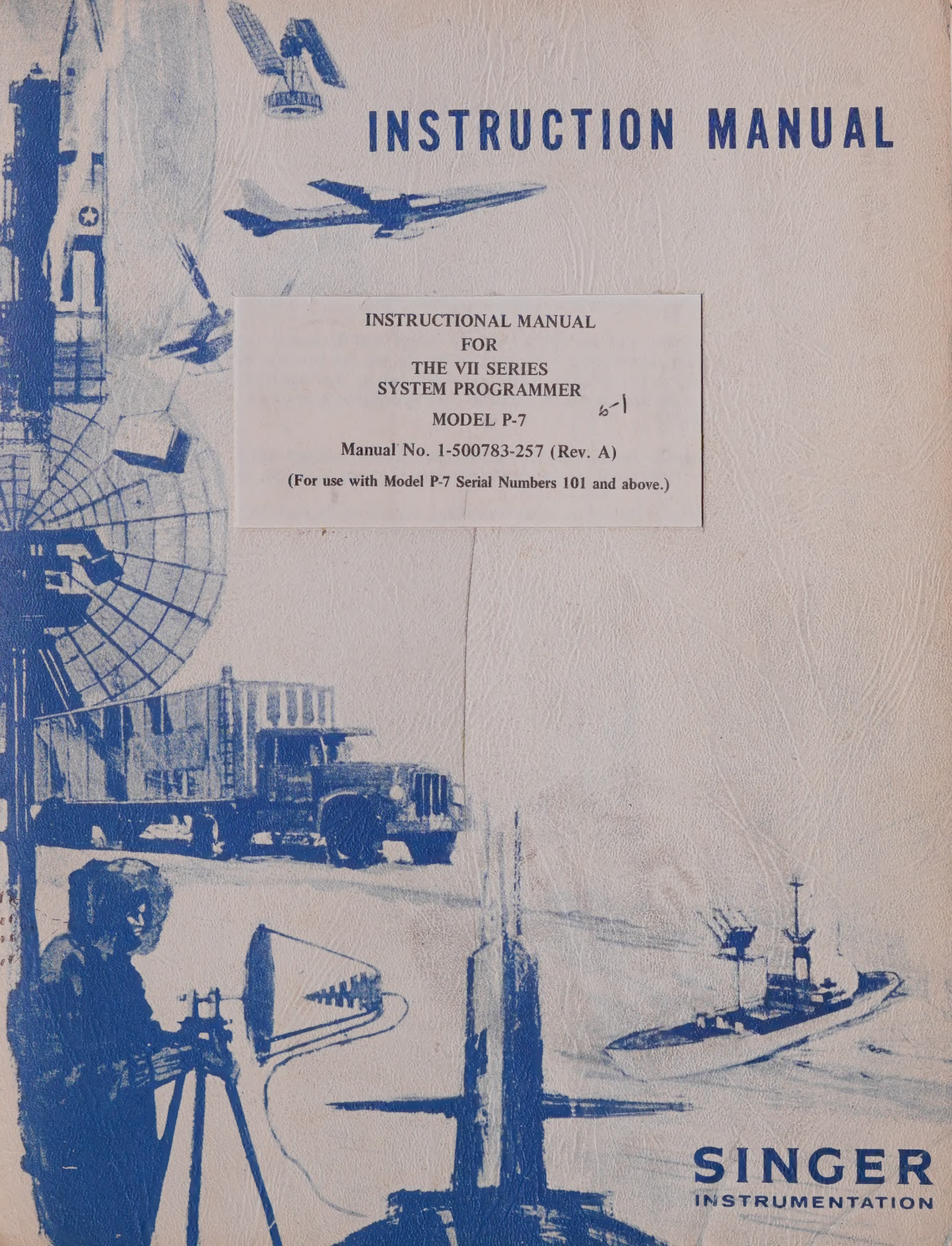
INSTRUCTION MANUAL



INSTRUCTIONAL MANUAL
FOR
THE VII SERIES
SYSTEM PROGRAMMER
MODEL P-7

Manual No. 1-500783-257 (Rev. A)

(For use with Model P-7 Serial Numbers 101 and above.)

SINGER
INSTRUMENTATION

INSTRUCTIONAL MANUAL
FOR
THE VII SERIES
SYSTEM PROGRAMMER
MODEL P-7

5-1

Manual No. 1-500783-257 (Rev. A)

(For use with Model P-7 Serial Numbers 101 and above.)

This manual refers directly to serial numbers 105 and above.
Appendix A, Manual Backdating Information, adapts this manual to serial numbers 101 thru 104.

1st Print 8/73
Revision A11/74

NOTE: **References to the Model NM-67 and the Interface Unit: These instruments are not yet available (11/74) and all related information is tentative.**

THE SINGER COMPANY
Los Angeles Operation
5340 Alla Road
Los Angeles, California 90066

WARRANTY

SINGER INSTRUMENTATION, LOS ANGELES OPERATION, (SELLER) warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

TCXO Oscillator ..... 2 Years
Electrical and Electronic Measuring Instruments..... 1 Year

Repair or replacement (at our option) without charge (F.O B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and RatioTran potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

This warranty is in lieu of all other warranties, express or implied INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY, or fitness for a particular purpose. In no event shall the SELLER be liable for INCIDENTAL OR CONSEQUENTIAL damages. The SELLER neither assumes, nor authorizes any person to assume for it, any other liability in connection with sales of instruments manufactured by SELLER.

With respect to repairs, the foregoing warranty shall apply for a period of ninety days to the repaired portion.

THE SINGER COMPANY, LOS ANGELES OPERATION
5340 Alla Road, Los Angeles, California 90066

REPAIR AND MAINTENANCE

Instruments should be returned only on prior authorization from the Singer Representative or the factory. You will be advised of detailed shipping instructions at that time. Return the instrument to the factory Prepaid. Validity of warranty will be determined by the factory.

Chargeable repairs: If requested, an estimate of charges will be made prior to repairs. Please provide us with the following information in order to expedite the processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(1)
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Has maintenance action been previously requested.
7. Other comments.

(1) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data.

To the user of SINGER Instrumentation:

SINGER instruments are fabricated and tested under conditions of rigid manufacturing and quality control according to the best practice of the current state of the art. In addition, our Service and Applications Sections are available to you at any time.

The registration of your instruments and any comments will be most appreciated. The information concerning fields of application will aid us in providing you with pertinent literature from time to time.

REGISTRATION CARD

SINGER
INSTRUMENTATION

Name _____

Address _____

Models: _____ Serial No. _____

Date _____ CONDITION ON ARRIVAL _____

FIELDS OF APPLICATION _____

SEND APPLICATION DATA TO: _____

COMMENTS: _____

_____

Name & Title

PLACE
STAMP
HERE

THE SINGER COMPANY
LOS ANGELES OPERATION
5340 Alla Road
Los Angeles, California 90066

CONTENTS

Section			Page No.
I	INTRODUCTION		
	1.1	Scope of Manual	1-1
	1.2	Purpose and Use of Equipment	1-1
	1.3	General Description	1-1
	1.4	Programmable Functions	1-1
	1.5	Accessories	1-1
	1.5.1	Supplied Accessoried	1-1
	1.5.2	Required Accessories	1-1
II	SPECIFICATIONS		
	2.1	Introduction	2-1
III	INSTALLATION		
	3.1	Introduction	3-1
	3.2	Bench Operation	3-1
	3.3	Rack Mounting	3-1
	3.4	115 V/230 V Operation	3-1
	3.5	Instrument Interconnections	3-1
	3.5.1	X-Y Recorder Mode	3-1
	3.5.2	CRT Mode	3-1
IV	OPERATING INSTRUCTIONS		
	4.1	Introduction	4-1
	4.2	Operating Controls, Indicators, and Receptacles	4-1
	4.3	Operating Procedures	4-9
	4.3.1	General	4-9
	4.3.2	CAL Control (Screwdriver-slotted) Adjustments	4-9
	4.3.3	Typical Operation	4-9
	4.3.4	Time Domain Measurements	4-11
	4.3.5	Operation by a Remote Digital Computer	
	4.3.6	Plots-per-page Format	4-11
	4.3.7	"Calibration" of X-Y Recorder Paper	4-14
V	THEORY OF OPERATION		
	5.1	Introduction	5-1
	5.2	Basic Principles of Operation	5-1
	5.2.1	Band Selection	5-1
	5.2.2	Display Mode Control	5-1
	5.2.3	Pen Control	5-2
	5.2.4	Scan Control	5-2
	5.2.5	Bandwidth Selection	5-2
	5.2.6	Detector Function Selection	5-2
	5.2.7	Data Multiplexing	5-2
	5.2.8	Attenuator-Antenna Switch Control	5.2
	5.2.9	Digital Display Control	5-2

CONTENTS (Cont.)

Section			Page No.
V	THEORY OF OPERATION (Cont.)		
	5.2.10	Digital Controller Interface	5-5
	5.3	Detailed Circuit Analysis	5-5
	5.3.1	Band Selection Circuitry	5-5
	5.3.2	Reset Circuitry	5-5
	5.3.3	Start Circuitry	5-5
	5.3.4	Sweep Circuitry	5-19
	5.3.5	Stop Circuitry	5-20
	5.3.6	X-Y Recorder Circuitry	5-20
	5.3.7	Digital Pen Position Control Circuitry	5-26
	5.3.8	Data Signal Multiplexing Circuitry	5-33
	5.3.9	Remote Attenuator Selection Circuitry	5-37
	5.3.10	Bandwidth Selection Circuitry	5-37
	5.3.11	Detector Function Selection Circuitry	5-37
	5.3.12	Digital Buffer Circuitry for Remote Digital Display Unit, Model DDU-7, and Remote Antenna Switch Model IU-7A	5-37
	5.3.13	Calibration Control Circuitry	5-37
	5.3.14	Digital Interface Circuitry	5-37
	5.3.15	Power Supply Circuitry	5-45
VI	MAINTENANCE		
	6.1	Introduciton	6-1
	6.2	Test Equipment Required	6-1
	6.3	Minimum Performance Procedure	6-1
	6.3.1	To Evaluate the Logic and Pen Control	6-1
	6.3.2	To Evaluate the Tuning Voltage	6-2
	6.3.3	To Evaluate the Band Select Control	6-2
	6.3.4	To Evaluate the Detector Function Control	6-3
	6.3.5	To Evaluate the Bandwidth Control	6-3
	6.3.6	To Evaluate the Log Video Multiplexer	6-3
	6.3.7	To Evaluate the Auxiliary Multiplexer	6-4
	6.3.8	To Evaluate the Simultaneous F1 Multiplexer	6-4
	6.3.9	To Evaluate the Remote Digital Display	6-4
	6.3.10	To Evaluuate the Antenna Switch	6-5
	6.4	Alignment and Adjustment Procedures	6-5
	6.4.1	Disassembly Procedures	6-5
	6.4.2	Sweep Generator Alignment	6-7
	6.4.3	Digital-to-Analog Converter Alignment	6-7
	6.4.4	Analog Multiplexer Alignment	6-7
VII	REPLACEABLE PARTS		
	7-1	Introduction	7-1
VII	SCHEMATIC DIAGRAMS		8-1

APPENDIX

Appendix		Page No.
A	Backdating Information	A-1

TABLES

Table		Page No.
1-1	Supplied Accessories	1-1
2-1	Specifications	2-1
4-1	Controls, Indicators and Receptacles	4-1
4-2	Program Receptacle Pin Data (J28, J21, J24, & J27)	4-16
4-3	Remote Digital Controller Receptacle Pin Data (J29)	4-17
4-4	Antenna Switch and Attenuator (Input Unit) Receptacle Pin Data (J30)	4-19
4-5	Remote Digital Display Unit Receptacle Pin Data (J36)	4-20
4-6	BCD Output Format	4-21
5-1	EMI/FI Meter Decoding Scheme	5-34
6-1	Test Equipment Requirements	6-1
6-2	Band Select Pin Locations	6-3
6-3	Band Select Bit Binary Code	6-5
7-1	Parts List for Main Assemblies and Chassis	7-2
7-2	Parts List for Miscellaneous Parts	7-10
7-3	Parts List for Supplied Accessories	7-11
7-4	Parts List for Sweep Generator Assembly, A1	7-12
7-5	Parts List for Digital-to-Analog Converter Assembly, A2	7-15
7-6	Parts List for Relay Driver Assemby, A3 & A4	7-17
7-6	Parts List for Band Decoder and Digital Multiplexer Assemblies, A5, A6 and A7	7-19
7-8	Parts List for Analog Multiplexer Assembly, A8	7-21
7-9	Parts List for Receiver Decode and Relay Driver Assembly, A9	7-23
7-10	Parts List for Logic Control Assembly, A10	7-24
7-11	Parts List for Digital Interface Assembly, A11	7-26
7-12	Parts List for Digital Pen Control Assembly, A12	7-28
7-13	Parts List for Auxiliary Multiplexer and Attenuator Control Assembly, A13	7-30
7-14	Parts List for Sweep Select Assembly, A14	7-32
7-15	Parts List for Calibration Voltage Source, Digital Buffer and Starter Logic Assembly, A15	7-34
7-16	Parts List for Auxiliary Multiplexer and Attenuator Control Assembly, A16	7-36
7-17	Parts List for Power Supply Assembly, PS1 and PS2	7-37
7-18	Parts List for Power Supply Assembly, PS3 and PS4	7-39
7-19	Code List of Manufacturers	7-41

ILLUSTRATIONS

Figure		Page No.
1-1	Series VII Programmer, Model P-7	1-0
3-1	Typical Interconnection Diagram	3-2
4-1	Controls, Indicators and Receptacles (Front and Rear Panels), Model P-7 Programmer	4-0
4-2	Typical X-Y Recorder Graph Sheet Cal Points	4-10
4-3	One Plot-per-page Format	4-12
4-4	Four Plots-per-page Format	4-12
4-5	Eight Plots-per-page Format	4-13
4-6	Sixteen Plots-per-page Format	4-15
4-7	Twenty-four Plots-per-page Format	4-15
5-1	Simplified Block Diagram, Model P-7	5-3
5-2	Functional Block Diagram, Band Select Circuitry	5-6
5-3	Detailed Block Diagram, Band Select Circuitry	5-7
5-4	Functional Block Diagram, Reset Circuitry	5-9
5-5	Detailed Block Diagram Reset, Stop, Start, and Sweep Circuitry	5-11
5-6	Functional Block Diagram, Logic Start Circuitry	5-15
5-7	Functional Block Diagram, Logic Control Circuitry	5-17
5-8	Timing Pulse Sequence Diagram	5-19
5-9	Binary Code. Enable Signals Timing Diagram	5-19
5-10	Functional Block Diagram, Sweep Generator Circuitry	5-21
5-11	Functional Block Diagram, Stop Circuitry	5-23
5-12	Functional Block Diagram, Digital-to-Analog Converter Circuitry	5-24
5-13	Functional Block Diagram, Sweep Select Circuitry	5-25
5-14	Detailed Block Diagram and X-Y Recorder Pen Control Circuitry	5-27
5-15	Functional Block Diagram, Pen Position Control Circuitry	5-29
5-16	One Plot-per-page Coding	5-30
5-17	Four Plots-per-page Coding	5-30
5-18	Eight Plots-per-page Coding	5-31
5-19	Sixteen Plots-per-page Coding	5-31
5-20	Twenty-four Plots-per-page Coding	5-32
5-21	Detailed Block Diagram, Analog Signal Multiplexing	5-35
5-22	Detailed Block Diagram, Remote Attenuator Switch Circuitry	5-38
5-23	Detailed Block Diagram, Bandwidth Switch Circuitry	5-39
5-24	Detailed Block Diagram, Detector Function Switch Circuitry	5-41
5-25	Detailed Block Diagram, Digital Buffer Circuit for Model DDU-7 and 1U-7A	5-43
5-26	Detailed Block Diagram, Calibration Control Circuitry	5-44
5-27	Detailed Block Diagram, Power Supply Circuitry	5-47
6-1	Location of Main Assemblies in Model P-7 Programmer	6-0
6-2	Trimmer Locations, Sweep Generator Assembly, A1	6-6
6-3	Trimmer Locations, D/A Converter Assembly, A2	6-6
6-4	Trimmer Locations, Analog Multiplexer Assembly, A8	6-6
6-5	Trimmer Locations, Logic Control Assembly, A10	6-6
6-6	Trimmer Locations, Calibration Reference Generator Assembly, A15	6-7

ILLUSTRATIONS (Cont.)

Figure (Cont.)		Page No.
6-7	Sweep Generator Delay Waveform	6-8
8-1	Schematic Diagram, Sweep Generator Assembly, A1	8-3
8-2	Schematic Diagram, D/A Converter Assembly, A2	8-5
8-3	Schematic Diagram, Relay Driver Assembly, A3, A4	8-7
8-4	Schematic Diagram, Band Decoder and Multiplexer Assembly, A5 thru A7	8-9
8-5	Schematic Diagram, Analog Multiplexer Assembly, A8	8-11
8-6	Schematic Diagram, Receiver Decode and Relay Driver Assembly, A9	8-13
8-7	Schematic Diagram, Logic Control Assembly, A10	8-15
8-8	Schematic Diagram, Digital Interface Assembly, A11	8-17
8-9	Schematic Diagram, Digital Pen Control Assembly, A12	8-19
8-10	Schematic Diagram, Auxiliary Multiplexer and Attenuator Control Assembly, A13 and A16	8-21
8-11	Schematic Diagram, Sweep Select Assembly, A14	8-23
8-12	Schematic Diagram, Calibration Voltage Source, Digital Buffer and Starter Logic Assembly, A15	8-25
8-13	Schematic Diagrams, Power Supply Circuit Assemblies, (PS1, PS2, PS3, PS4)	8-27
8-14	Wiring Diagram, Model P-7	8-29

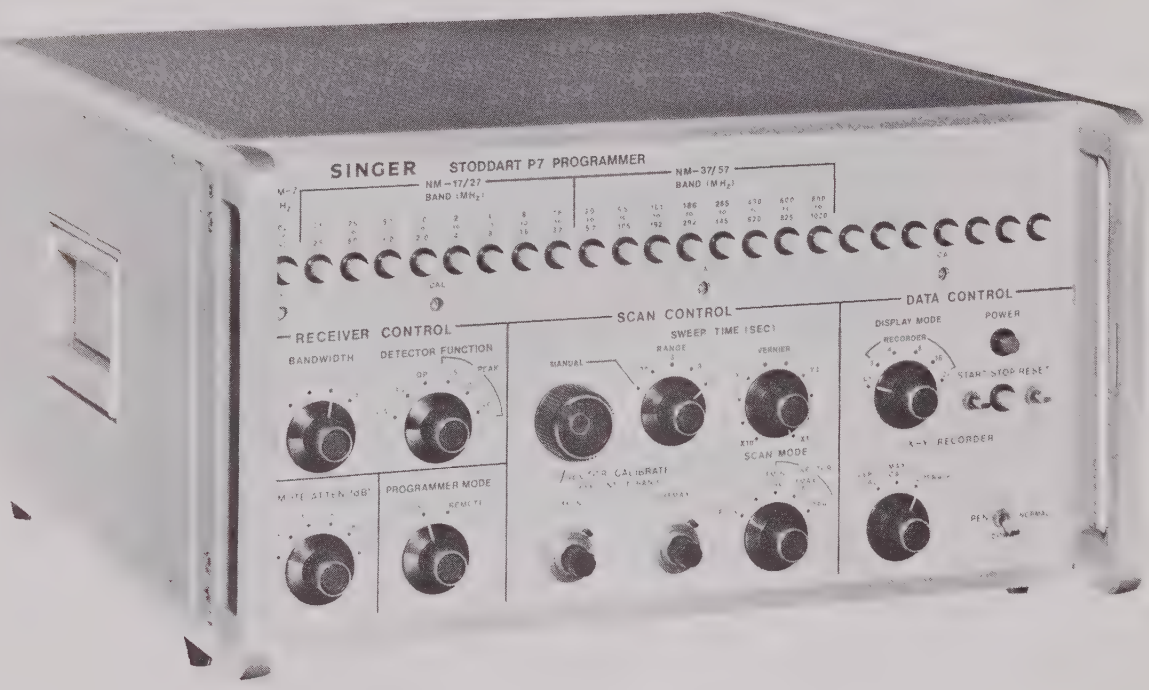


Figure 1-1. Series VII Programmer, Model P-7

Section 1
INTRODUCTION

1.1 SCOPE OF MANUAL

This manual provides operating and maintenance information for the Model P-7 Programmer (Figure 1-1). The manual is divided into eight sections containing an introduction, specifications and operating characteristics, installation, operating instructions, theory of operation, maintenance, replaceable parts, and schematic diagrams. The abbreviations for units in this manual follow the IEEE "Standard Symbols for Units" (IEEE No. 260).

1.2 PURPOSE AND USE OF EQUIPMENT

The Model P-7 Programmer is a programmable control unit designed to interface with Series VII (Models NM-7, NM-17/27, NM-37/57, and NM-67) Electromagnetic Interference/Field Intensity (EMI/FI) Meters. The Programmer is capable of controlling any or all of these EMI/FI measuring devices and accumulating data with appropriate equipment. The instrument performs automatic and semiautomatic testing when supplied with appropriate command signals and provides outputs of signal amplitude and frequency that are suitable for input to a digital data processing system. An Input Unit, Model IU-7A, provides remote control of antenna selection for Series VII EMI/FI Meters. A programmable RF attenuator in 20 dB steps, from 0 dB to 100 dB, is also provided. An Interface Unit converts computer serial information to parallel information for use with the Series VII EMI/FI Meter system. A Digital Display Unit, Model DDU-7, displays signal amplitude (including attenuator settings) in dB referred to 1 uV and frequency in kHz, MHz, or GHz automatically. It also has BCD outputs for a remote printer or for providing information back to the Interface Unit and then to a computer. Some typical applications of the Model P-7 are:

a. Automatic plotting of conducted signal level (or field intensity when used with antennas) as a function of frequency in either single or multi-band modes.

b. Expanded tuning in either a Δf sweep mode or a sector sweep mode.

c. Visual spectral display of input signal.

d. Time domain display of input signal.

1.3 GENERAL DESCRIPTION

The instrument is rugged and operates from 115 V ac or 230 V ac, 47 Hz to 420 Hz power. It is an ideal unit for use with a recorder or an oscilloscope and the appropriate EMI/FI Meters to form a high-speed, high volume mobile test station. The instrument will control all EMI/FI Meter functions necessary to obtain accurate data. These functions include: frequency band selection, IF bandwidth selection, receiver gain adjustment, detector function selection, and frequency tuning. Additionally, a remote antenna/attenuator may be programmed. Provisions have been incorporated to facilitate data recording. Calibration points are available for the X-axis and Y-axis of an X-Y recorder and the Y-axis of a CRT. The calibrated data range is 0 dB to +60 dB (−10 dB to +70 dB total dynamic range). Outputs to a remote Digital Display Unit include amplitude and frequency signals from the EMI/FI Meters.

1.4 PROGRAMMABLE FUNCTIONS

It is possible to control the Model P-7 Programmer remotely, through a digital interface.

The following functions are remotely programmable:

a. Frequency band selection

b. Bandwidth selection

c. Remote attenuator position

d. Detector function selection

e. Sweep rate control

f. Sweep range control

g. Start control

h. Reset control

i. Plotting mode selection

j. Stop control

1.5 ACCESSORIES

1.5.1 Supplied Accessories

The items listed in Table 1-1 are furnished with the Model P-7 Programmer.

Table 1-1. Supplied Accessories

Quantity	Device	Singer Part No.
1	AC Power Cord, 7-1/2 ft.	1-910166-001
1	Instruction Manual	1-500783-257
2	Rack Mounting Brackets	3-103317-001
4	10-32 x 1/2 flat-head screws	1-964064-265

1.5.2 Required Accessories

For complete operation of the Model P-7 Programmer, it is necessary to have the following accessories, in addition to the supplied accessories listed in Paragraph 1.5.1.

a. *Programmer Cable,* Model 94595-1. This is a 6 ft. cable with 41 pin connectors, used for interface with the EMI/FI Meters. One required for each EMI/FI Meter.

b. *Interconnecting Cable,* Model 94596-1. This is a 6 ft. coaxial cable with BNC connectors used for log video input, X-axis and Y-axis recorder inputs and X-axis and Y-axis CRT inputs. One required for each EMI/FI Meter, two required for a recorder and two required for an oscilloscope.

c. *Interconnecting Cable,*Model 94604-2. This is a 6 ft. cable with 19 pin connectors used for either connecting the Model P-7 to the Model DDU-7 or for connecting the Model P-7 to the Model IU-7A.

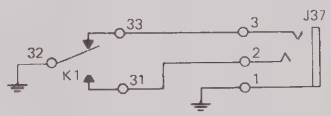
d. *Pen Lift Cable,* Model 94610-1. This is a 6 ft. cable with BNC and telephone jack connectors used for connecting the PEN CONTROL receptacle of the Model P-7 to an X-Y recorder.

Section II
SPECIFICATIONS

2.1 INTRODUCTION

This section contains specification information for the Model P-7 Programmer. Refer to Table 2-1.

Table 2-1. Specifications

Parameter	Specifications
Tuning voltage (for remote EMI/FI Meters)	
range:	0 V to +10.0 V nominal into 2 kilohm load
sweep dial accuracy:	±0.2%
repeatablility:	±0.1%
tuning rate:	Adjustable from 30 ms/sweep nominal to 300 s/sweep nominal, or manual operation
hum and noise:	Less than 50 uV wideband composite
Video display bandwidth:	Dc to 5.0 MHz minimum
Sweep drift in STOP mode:	Approximately 5 mV/second (20 seconds for 1% drift)
Plotting modes:	1 plot/page, 4 plot/page, 8plot/page*, 16 plot/page*, and 24 plot/page*
X-Y recorder interface:	
X-data and Y-data open-circuit signal characteristics:	Voltage range: 0 volts to 2.0 volts nominal Current range: ±20.0 milliamperes (limited) Output impedance: Z_O=1000 ohms maximum
Pen control:	The pen control signal is a relay closure. The pen is down when the relay is closed. No relay contact is connected internally to the Programmer. Signal handlying capabilities are 2.0 amps resistive, 1.0 amp inductive and 350 V rms.
CRT interface:	
X-data characteristics:	Voltage Range: ±5.0 volts nominal Current Range: ±20.0 milliamperes (limited) Output Impedance: Z_O =10 ohms maximum
Y-data characteristics:	Voltage Range: 0 volts to 60.0 millivolts nominal into 1 megohm load Output Impedance: Z_O=300 ohms maximum
Z-blanking:	The Z-axis blanking is a normally open or normally closed switch to ground that may be used with appropriate resistors for use with oscilloscopes having grid blanking or cathode blanking. Z-blanking should be used only with the oscilloscope connected to the X-Y RECORDER receptacles. 
Auxiliary interface:	Series "on" Impedance: R_S=0.1 ohm maximum Channel to channel rejection: 60 dB minimum Input voltage limits: ±50 volts Input current limits: ±1.0 amp (resistive load) Power handling capability: 5.0 watts maximum
Remote attenuator interface:	The attenuator interface is implemented with SN7406 (or equivalent) hex inverter buffer drivers. These open collector drivers are not terminated in the Programmer. Voltage Range: 0 volts to 30.0 volts nominal (high level depends on attenuator termination) Current Range: 0 milliamperes to 40.0 milliamperes Logic "true": 0 volts

* Dedicated Bands (refer to Paragraph 4.3.6 for explanation)

Table 2-1. Specifications (Cont.)

Parameter	Specifications
Remote digital display interface:	The interface with the remote digital display includes a number of digital signals and three analog signals; the frequency signals,weighted dB signals, and multiplexed Y-data signals. The digital interface is exactly like that of the remote attenuator.
Remote digital controller interface:	The drivers in the controller interface shall be open collector devices that have the following characteristics: Voltage Range: 0 volts to ±5.0 volts nominal Current Range: 1_i=20.0 milliamperes maximum Logic "true": 0 volts
	The controller inputs are logically "ORed" with the programmer inputs. As a result, the controller must maintain these inputs "false" when it is not controlling the programmer The ground to the controller is open-circuited when the Programmer is in the LOCAL mode.
Input power:	115V or 230V rms, 47 Hz to 420 Hz, approximately 100 watts.
Temperature range:	0° to +50°C (+32°F to +122°F)
Dimensions (including handles):	Approximate Height: 22 cm (8-3/4 inches) Approximate Width*: 43 cm (16-3/4 inches) Approximate Depth: 47 cm (18-1/2 inches)
Weight:	Approximately 19 kg (41 pounds)

* Excluding rack mounting brackets

Section III
INSTALLATION

3.1 INTRODUCTION

This section provides instruction for bench operation vs. rack mounting, 115 V/ 230 V operation, and typical instrument interconnections.

3.2 BENCH OPERATION

The Model P-7 Programmer is shipped ready for use as a bench-operated instrument. A folding support that is attached to the feet under the front of the instrument may be pulled down to tilt and elevate the instrument if desired.

3.3 RACK MOUNTING

A set of Rack Mounting Brackets and attaching screws are provided to permit mounting of the Model P-7 in a standard 19-inch rack. To prepare the instrument for rack mounting, proceed as follows:

a. Remove six screws attaching four feet and folding support to bottom of instrument.

b. Attach one Rack Mounting Bracket (Part No. 3-103317-001) to each side of the instrument using two 10-32 x 1/2 flathead screws (Part No. 1-964064-265) in each bracket.

3.4 115 V/230 V OPERATION

The Model P-7 Programmer is designed for either 115 V or 230 V operation. Set the slide switch on the back panel for the desired operating voltage. For 115 V operation, use 3 A slo-blo fuses; for 230 V operation, use 1.5 A slo-blo fuses.

3.5 INSTRUMENT INTERCONNECTIONS

Figure 3-1 displays typical instrument interconnections for the operation of the Model P-7 with the Models NM-17/27 and NM-37/57 EMI/FI Meters.

3.5.1 X-Y Recorder Mode

a. Connect the PROGRAM receptacle of the EMI/FI Meter(s) to the appropriate PROGRAM receptacle(s) on the rear panel of the Model P-7.

b. Connect the X receptacle of the X-Y recorder to the X-Y RECORDER X DATA receptacle on the rear panel of the Model P-7.

c. Connect the Y receptacle of the X-Y recorder to the X-Y RECORDER Y DATA receptacle on the rear of the Model P-7.

d. Connect the pen receptacle of the X-Y recorder to the X-Y RECORDER PEN CONTROL receptacle on the rear panel of the Model P-7.

NOTE

An oscilloscope may be used in place of the X-Y recorder by connecting: (a) the horizontal input receptacle to the X-Y RECORDER X DATA receptacle on the rear panel of the Model P-7; (b) the vertical input receptacle to the X-Y RECORDER Y DATA receptacle on the rear panel of the Model P-7; and (c) the Z blanking to the CRT Z BLANK receptacle on the rear panel of the Model P-7.

3.5.2 CRT Mode

a. Connect the PROGRAM receptacle of the EMI/FI Meter(s) to the appropriate PROGRAM receptacle(s) on the rear panel of the Model P-7.

b. Connect the LOG receptacle of the EMI/FI Meter(s) to the appropriate LOG receptacle(s) on the rear panel of the Model P-7.

c. Connect the horizontal input receptacle of the oscilloscope to the CRT X DATA receptacle on the rear panel of the Model P-7.

d. Connect the vertical input receptacle of the oscilloscope to the CRT Y DATA receptacle on the rear panel of the Model P-7.

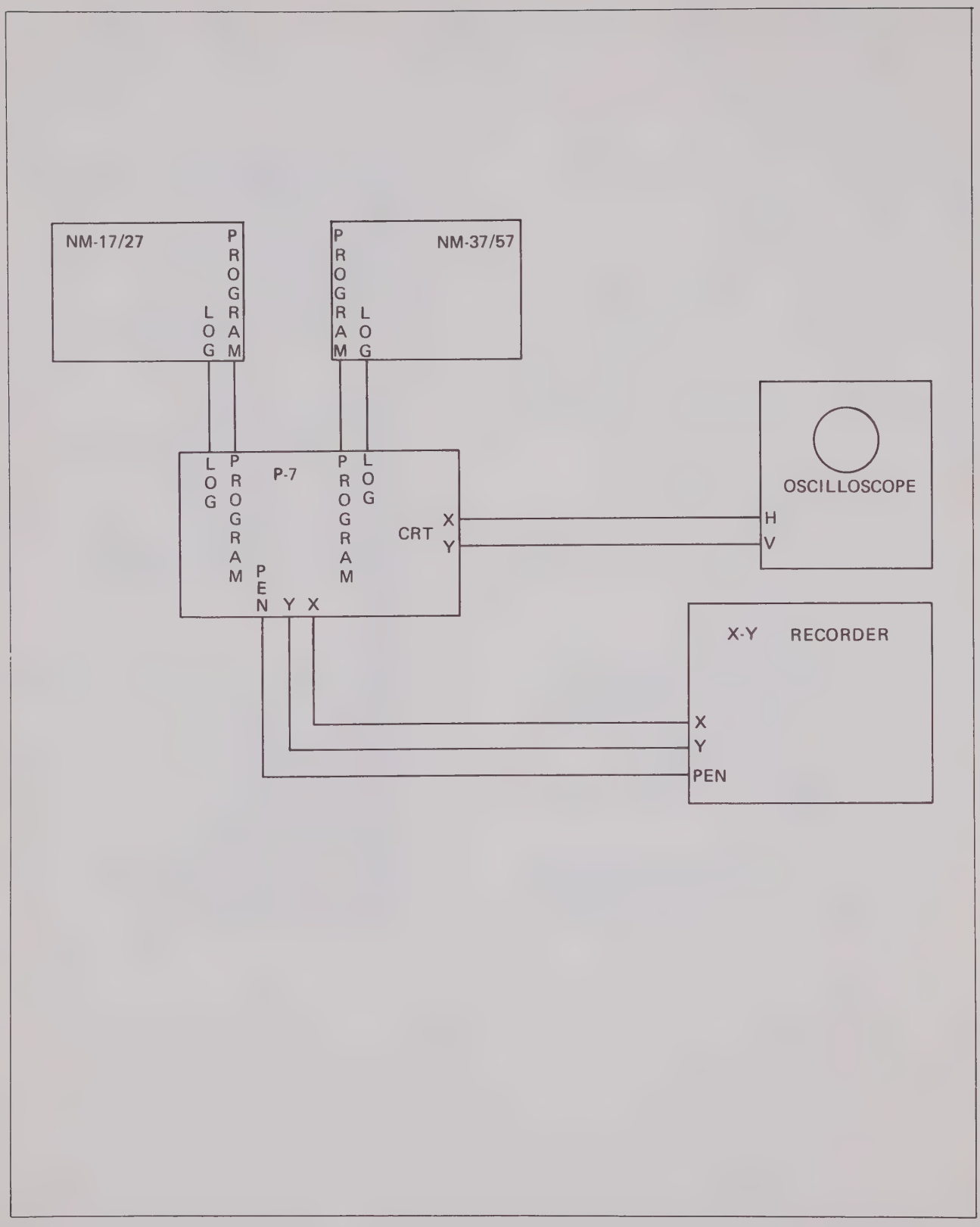


Figure 3-1. Typical Interconnection Diagram

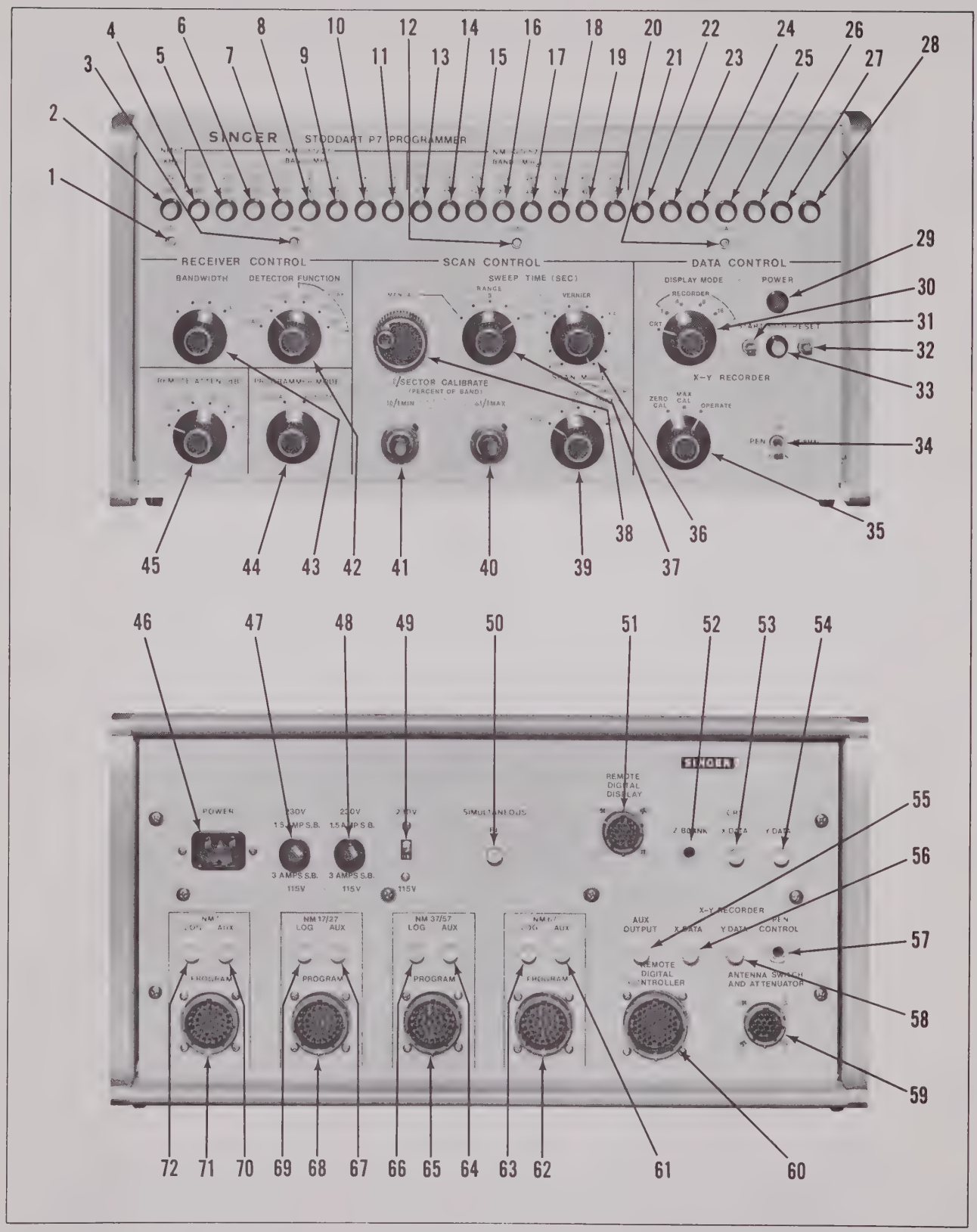


Figure 4-1. Controls, Indicators and Receptacles (Front and Rear Panels), Model P-7 Programmer

Section IV
OPERATING INSTRUCTIONS

4.1 INTRODUCTION

Instructions and information for using the Model P-7 and a functional description of controls, indicators and receptacles is presented in this section of the manual.

4.2 OPERATING CONTROLS, INDICATORS, AND RECEPTACLES

All external operating controls, indicators, and receptacles of the Model P-7 are located on the front and rear panel (Figure 4-1). Functions of the front panel and rear panel features are described in Table 4-1.

Table 4-1. Controls, Indicators and Receptacles (Keyed to Figure 4-1)

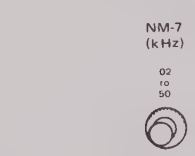
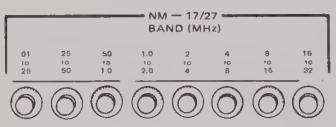
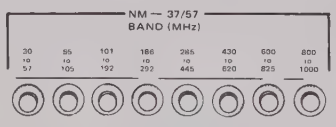
Item	Panel Marking	Description	Function
1		Variable resistor (R1)	Provides the means for remotely controlling the CAL gain of the Model NM-7 EMI/FI Meter.
2		Illuminated push-push switch, white lens (S2)	Provides the means for selection of the Model NM-7. Depressing this pushbutton will illuminate it dimly to indicate that the Model NM-7 is to be swept. When the band is being swept, the illumination of the pushbutton is increased to full brightness.
3		Variable resistor (R2)	Provides the means for remotely controlling the CAL gain of the Model NM-17/27 EMI/FI Meter.
4 thru 11		8 illuminated push-push switches, white lens (S3 thru S10)	Provides the means for selection of the desired bands to be swept of the Model NM-17/27. Depressing these pushbuttons will illuminate them dimly to indicate the band that is to be swept. When the band is being swept, the illumination increases to full brightness.
12		Variable resistor (R3)	Provides the means for remotely controlling the CAL gain of the Model NM-37/57 EMI/FI Meter.
13 thru 20		8 illuminated push-push switches, white lens (S11 thru S18)	Provides the means for selection of the desired bands of the Model NM-37/57 to be swept. Depressing these pushbuttons will illuminate them dimly to indicate the band that is to be swept. When the band is being swept, the illumination increases to full brightness.
21		Variable resistor (R4)	Provides the means for remotely controlling the CAL gain of the Model NM-67 EMI/FI Meter.

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

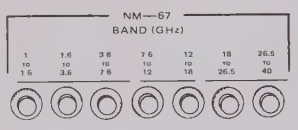
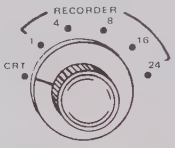
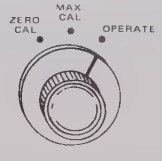
Item	Panel Marking	Description	Function
22 thru 28		7 illuminated push-push switches, white lens (S19 thru S25)	Provides the means for selection of the desired bands to be swept of the Model NM-67. Depressing these pushbuttons will illuminate them dimly indicating the band that is to be swept. The illumination is increased to full brightness when the band is being swept. (The last two bands will be contained in an auxilliary device.)
29	DATA CONTROL POWER 	Illuminated push-push switch, red lens (S26)	Provides the means for energizing the Model P-7 Programmer.
30	DISPLAY MODE 	6 position rotary switch (S30)	Provides the means for controlling the number of plots-per-page or selection of the CRT mode.
31	START 	Momentary toggle switch (S29)	Provides the means for starting the clock. The logic is automatic and no further action is necessary once the START switch has been actuated.
32	RESET 	Momentary toggle switch (S27)	Provides the means for resetting the sweep and all logic to the original state. All action is halted until further commands are given.
33	STOP 	Illuminated push-push switch, yellow lens (S28)	Provides the means for stopping the Programmer in the middle of a sweep. This action also forces the pen to lift. The sweep output remains constant until further action is taken by the operator. When the STOP switch is deactivated, the pen drops and the sweep continues.
34		3 position toggle switch (S34)	Provides the means for controlling the pen position. In the NORMAL position, the pen is automatically controlled by the Programmer. UP and DOWN positions may be used to control the pen up and down regardless of the automatic control of the Programmer.
35	X-Y RECORDER 	3 position rotary switch (S35)	Provides the means for determining the maximum and minimum limits of the pen movement so that an X-Y recorder may be calibrated. Also the Y-axis of an oscilloscope may be calibrated.

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

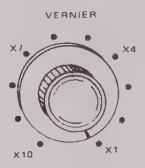
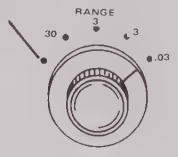
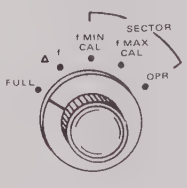
Item	Panel Marking	Description	Function
	SCAN CONTROL		
36	SWEEP TIME (SEC) VERNIER  	Variable resistor (R5)	Provides the means for controlling the duration of the automatic sweep. The RANGE switch controls decades and the VERNIER control is continuously adjustable from times one to times ten. The overall range of SWEEP TIME is from 30 milliseconds to 300 seconds. The RANGE switch may also be set to the MANUAL position. In this position the MANUAL control is used to tune the selected EMI/FI Meter.
37	RANGE  	5 position rotary switch (S31)	
38	MANUAL 	10 turn variable resistor (R6)	
39	SCAN MODE  	5 position rotary switch (S36)	Provides the means for controlling the scan of the EMI/FI Meter. The SCAN MODE switch and Δf/ SECTOR CALIBRATE controls are used to determine what portion of the total tune voltage (0-10 V) will be sent to the EMI/FI Meter. The three basic modes are: full sweep range; Δf; and sector. The operation is as follows: FULL: The entire zero to 10 volt sweep voltage is used to tune one complete band of the EMI/FI Meter.
40	Δ f/SECTOR CALIBRATE (PERCENT OF BAND) Δ f/f MAX 	10 turn variable resistor (R7)	Δf: The fo/fMIN control will indicate the center point of the sweep. The Δf/fMAX control will indicate what percentage of the sweep will be used to tune the voltage. The sweep range will be from fo −Δf/2 to fo + Δf/2. SECTOR: The fo/fMIN control will indicate the starting point of the sweep. The ending point will be the sum of the fo/fMIN control and Δf/fMAX control settings. The sweep range is then from fMIN to fMIN + fMAX.
41	fo/f MIN 	10 turn variable resistor (R8)	Example: To sweep from 30–50% of the frequency range, set fo/fMIN control to 3.0 and the Δf/fMAX control to 2.0.

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

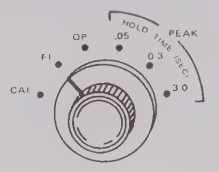
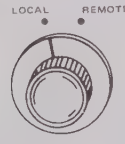
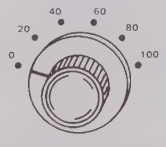
Item	Panel Marking	Description	Function
42	**RECEIVER CONTROL** DETECTOR FUNCTION  	6 position rotary switch (S32)	Provides the means for determining the mode of detection in the controlled EMI/FI Meter. The CAL position disconnects the RF input and energizes a calibrating generator inside the EMI/FI Meter, enabling the EMI/FI Meter gain to be standardized remotely with the proper CAL potentiometer (located on the control panel directly below the Band Select pushbuttons). The FI position selects the Field Intensity mode of detection. The QP position selects the Quasi-Peak detector function. The PEAK positions select the peak signal value with a different holding time for each of the three PEAK positions (50 milliseconds, 300 milliseconds, and 3.0 seconds).
43	BANDWIDTH 	4 position rotary switch (S33)	Provides the means for controlling the calibrated bandwidth of the EMI/FI Meter being swept. The actual bandwidth is a function of the bandwidth control setting and the EMI/FI Meter currently being swept, as in the following: NM-7 / NM-17/27 1. 10 Hz / 100 Hz 2. 100 Hz / 1 kHz 3. 1 kHz / 10 kHz 4. 1 kHz / 50 kHz NM-37/57 / NM-67* 1. 10 kHz / Narrow 2. 100 kHz / Medium 3. 1 MHz / Wide 4. 1 MHz / Wide *Check Operator's manual for frequencies.
44	PROGRAMMER MODE  	2 position rotatry switch (S37)	Provides the means for determining whether operation is controlled by the Model P-7 Programmer control panel (LOCAL) or by a remote digital controller (REMOTE).
45	REMOTE ATTEN (dB)  	6 position rotary switch (S38)	Provides the means for sending logic signals through the rear panel to operate a remote attenuator assembly, such as the Model IU-7A.
46	POWER 	3 pin receptacle (FL1)	Provides input for ac power.

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

Item	Panel Marking	Description	Function
47	230V 1.5 AMP S.B. 3 AMPS S.B. 115V	Fuse (F2)	Provides access to the ac line fuse. Use 3A SB for 115 V operation and 1.5 A SB for 230 V operation.
48	230V 1.5 AMP S.B. 3 AMPS S.B. 115V	Fuse (F1)	Provides access to the ac line fuse. Use 3A SB for 115 V operation and 1.5 A SB for 230 V operation.
49	230V 115V	Slide switch (S1)	Provides means for selecting operation of Model P-7 for either 230 V or 115 V input power.
50	SIMULTANEOUS FI 	BNC receptacle (J35)	Provides simultaneous FI output of any EMI/FI Meter when the FUNCTION switch is set to PEAK and the EMI/FI Meter is energized.
51	REMOTE DIGITAL DISPLAY 	19 pin receptacle (J36)	Provides the means for connecting the remote Digital Display Unit, Model DDU-7, to the Model P-7. (See Table 4-5 for pin assignments and interface levels.)
52	**CRT** Z BLANK 	Microphone jack receptacle (J37)	Provides both a contact closure and a contact opening for eliminating the retrace line for storage oscilloscope X-Y recording. (Mates with a military type PJ-068 microphone plug.)
53	X DATA 	BNC receptacle (J38)	Provides data to the X-axis of an oscilloscope.
54	Y DATA 	BNC receptacle (J39)	Provides data to the Y-axis of an oscilloscope.

Table 4-1. Controls, Indicators and Receptacles (Cont.)

(Keyed to Figure 4-1)

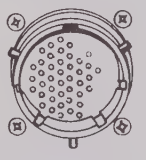
Item	Panel Marking	Description	Function
55	AUX OUTPUT	BNC receptacle (J31)	Provides output for any input to AUX receptacles, Items 61, 64, 67 and 71, when appropriate EMI/FI Meter is selected by Band Select switches (Items 18 thru 41).
56	**X-Y RECORDER** X DATA	BNC receptacle (J32)	Provides data to the X-axis of an X-Y recorder.
57	PEN CONTROL	Microphone jack receptacle (J34)	Provides a contact closure to drop the pen of an X-Y recorder. (Mates with a military type PJ-068 microphone plug.)
58	Y DATA	BNC receptacle (J33)	Provides data to the Y-axis of an X-Y recorder.
59	ANTENNA SWITCH AND ATTENUATOR	19 pin receptacle (J30)	Provides the means for connecting the remote attenuator and remote antenna, Model IU-7A, to the Model P-7 for operation by the Model P-7. (See Table 4-4 for pin assignments and interface levels.)
60	REMOTE DIGITAL CONTROLLER 	55 pin receptacle (J29)	Provides the means for connecting the Model P-7 to a digital computer for the purpose of fully automatic operation of the system. (See Table 4-3 for pin assignments and interface levels.)
61	**NM-67** AUX	BNC receptacle (J28)	Provides the means for any input to this receptacle to appear at AUX OUTPUT receptacle (Item 55) when Model NM-67 is selected by Model P-7.

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

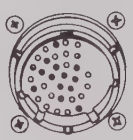
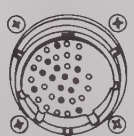
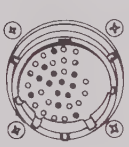
Item	Panel Marking	Description	Function
62	PROGRAM 	41 pin receptacle (J27)	Provides the means of connecting the Model P-7 to the Model NM-67 for remote control. (See Table 4-2 for pin assignments and interface levels.)
63	LOG	BNC receptacle (J26)	Provides the means for connecting the log video input from the Model NM-67 for CRT display.
64	**NM-37/57** AUX	BNC receptacle (J25)	Provides the means for any input to this receptacle to appear at AUX OUTPUT receptacle (Item 55) when Model NM-37/57 is selected by Model P-7.
65	PROGRAM	41 pin receptacle (J24)	Provides the means for connecting the Model P-7 to the Model NM-37/57 for remote control. (See Table 4-2 for pin assignments and interface levels.)
66	LOG	BNC receptacle (J23)	Provides the means for connecting the log video input from the Model NM-37/57 for CRT display.
67	**NM-17/27** AUX	BNC receptacle (J22)	Provides the means for any input to this receptacle to appear at AUX OUTPUT receptacle (Item 55) when Model NM-17/27 is selected by Model P-7.
68	PROGRAM 	41 pin receptacle (J21)	Provides the means for connecting the Model P-7 to the Model NM-17/27 for remote control. (See Table 4-2 for pin assignments and interface levels.)

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

Item	Panel Marking	Description	Function
69	LOG	BNC receptacle (J20)	Provides the means for connecting the log video input from the Model NM-17/27 for CRT display.
70	**NM-7** PROGRAM 	41 pin receptacle (J18)	Provides the means for connecting the Model P-7 to the Model NM-7 for remote control (See Table 4-2 for pin assignments and interface levels.)
71	AUX	BNC receptacle (J19)	Provides the means for any input to this receptacle to appear at AUX OUTPUT receptacle (Item 55) when Model NM-7 is selected by Model P-7.
72	LOG	BNC receptacle (J17)	Provides the means for connecting the log video input from the Model NM-7 for CRT display.

4.3 OPERATING PROCEDURES

4.3.1 General

Refer to Section III for installation procedures and 115 V or 230 V operation.

4.3.2 CAL Control (Screwdriver-slotted) Adjustments

a. Connect the Model P-7 to the appropriate equipment as displayed in Figure 3-1.

b. Set all EMI/FI Meters to the REMOTE control mode.

c. Set the Model P-7 controls as follows:

PROGRAMMER MODE	LOCAL
DISPLAY MODE	RECORDER 4
SWEEP TIME RANGE	MANUAL
DETECTOR FUNCTION	CAL
POWER	On

d. Depress one Band Select pushbutton of each EMI/FI Meter that is required to cover the frequency range of interest.

e. Depress the RESET switch.

f. Depress the START switch.

g. Determine a frequency that is near mid-scale on the Frequency meter of the selected EMI/FI Meter that coincides with a calibration point on the Calibration Chart. Vary the MANUAL control so that the Frequency meter indicates this frequency.

h. Adjust the CAL control, on the Model P-7, of the selected EMI/FI Meter so that the EMI/FI Meter Output meter indicates the calibration figure on the Calibration Chart.

i. Actuate the START switch to advance to the selected band on the next EMI/FI Meter, if required, and repeat Steps g and h for all selected EMI/FI Meters.

4.3.3 Typical Operation

The following switch and control positions are for typical operation; they may be varied as desired, however, by the operator.

a. Set all EMI/FI Meter ATTENUATOR switches as necessary to maintain the signal level on-scale on the Output meters.

NOTE

If a remote attenuator is used, rotate the ATTENUATOR switch of each EMI/FI Meter ccw so that the noise level indications, as noted on the Output meters, are near the low ends of the meter scales. Then select the REMOTE ATTEN (dB) switch position as necessary to maintain the signal level on-scale on the Output meters.

b. Set the Model P-7 controls as follows:

BANDWIDTH	2
DETECTOR FUNCTION	PEAK 0.3 SEC
SCAN MODE	FULL
SWEEP TIME RANGE (SEC)	0.3 for CRT display; 3 for X-Y Recorder
SWEEP TIME VERNIER	X1
PEN	NORMAL

c. Select the bands of interest by depressing the appropriate pushbutton switches. (The selected Band Select indicators should light dimly.)

d. Set the DISPLAY MODE switch to the CRT position for a CRT display, or if an X-Y recording is preferred, to the RECORDER position that will cover the number of bands selected in Step c.

NOTE

Refer to Paragraph 4.3.6 for Plot-per-page format.

e. Set the X-Y RECORDER switch to the ZERO CAL position and adjust the X-Y Recorder X and Y axes zero controls to position the pen in the lower left-hand corner of the graph paper as displayed in Figure 4-2. Momentarily set the PEN switch to the DOWN position to assure that the pen lines up with the lower left-hand corner of the graph paper. If in the CRT mode, set the horizontal amplitude controls of the oscilloscope to 1 volt per division and then set the vertical and horizontal position controls to set the dot on the first graticule line above the lowest graticule line and in the center of the screen horizontally.

f. Set the X-Y RECORDER switch to the MAX CAL position and adjust the X-Y recorder X and Y axes gain controls to position the pen in the upper right-hand corner of the graph paper as displayed in Figure 4-2. If in the CRT mode, set the vertical gain control to set the dot on the seventh graticule line above the lowest graticule line.

g. Repeat Steps e and f as necessary as there is interaction between the two switch positions.

h. Set the X-Y RECORDER switch to the OPERATE position.

NOTE

Refer to Paragraph 4.3.7 for "calibration" of X-Y recorder paper.

i. Depress the RESET switch.

j. Depress the START switch. If in the X-Y RECORDER mode, after approximately 3 seconds the pen will drop, the recording will begin and then proceed through the selected bands. On multi-band plots, any band or bands with signals of interest may be expanded by using the 1 plot-per-page mode. Also see SECTOR MODE, Step k. If in the CRT mode, the farthest left band will be energized. When desired, the next band may be displayed by de-energizing the Band Select switch for the band being observed, depressing the RESET switch, and reactivating the START switch. Repeat this procedure for the remaining bands selected.

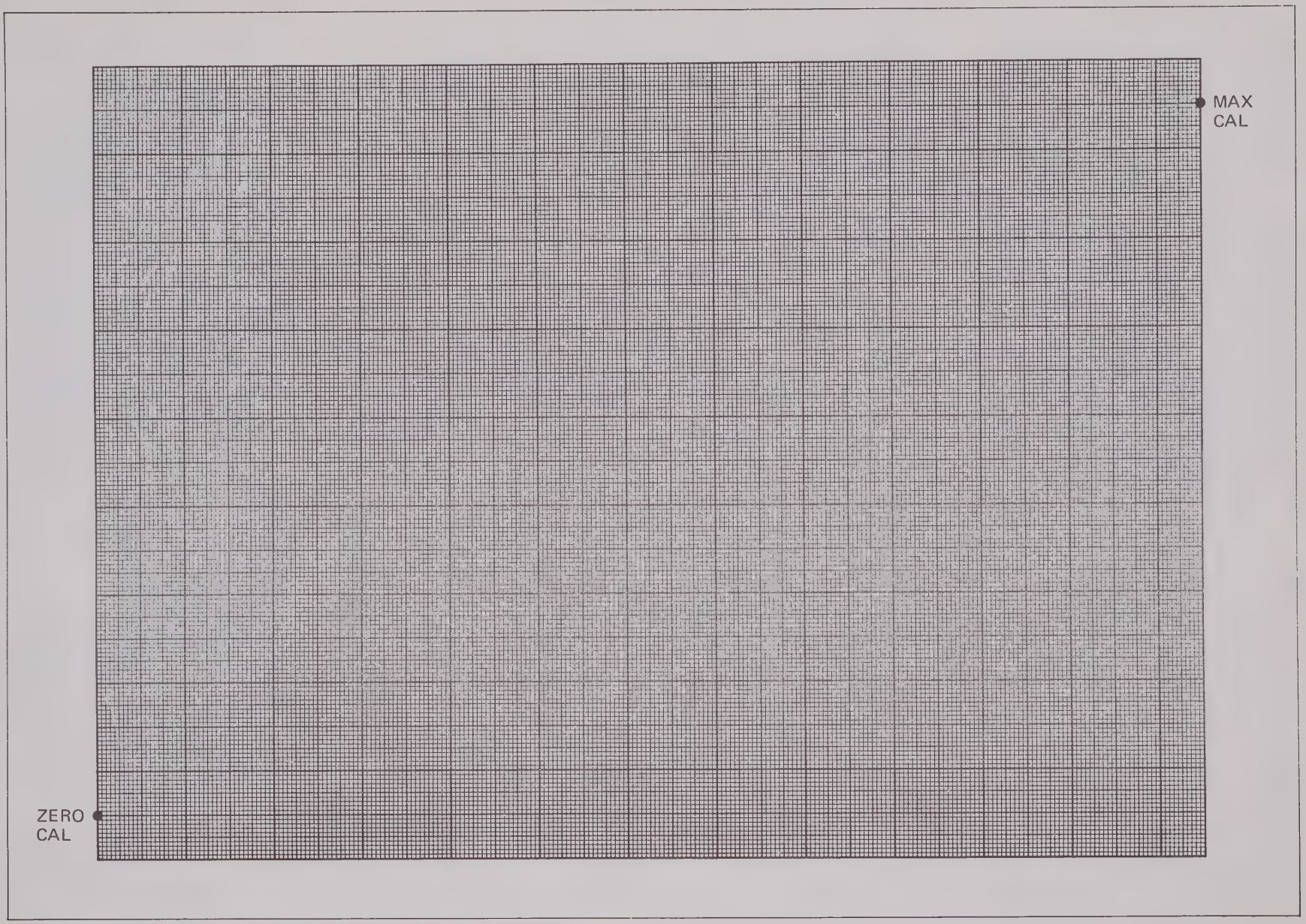


Figure 4-2. Typical X-Y Recorder Graph Sheet Cal Points

NOTE

To determine the frequency of an observed signal, rotate the MANUAL control until the marker pip on the retrace is in line with the signal to be investigated. Set the SWEEP TIME RANGE switch to the MANUAL position. The Frequency meter of the selected EMI/FI Meter will indicate the approximate frequency. Tune the MANUAL control for maximum Output meter indication for a more accurate frequency indication on the Frequency meter. An alternate method of selecting the bands is to actuate only the highest band to be observed. Then activation of a band to the left is all that is required to observe the next band. Repeatedly actuate the Band Select switches to the left until all desired bands have been selected and displayed.

k. For higher frequency resolution, the Δf or SECTOR SCAN mode may be used for either swept or manual operation. Δf is normally used for the CRT mode, while SECTOR is normally used for X-Y recordings.

Δf MODE

Set SCAN MODE switch to Δf position. The center frequency may be located with the "Manual Marker" as in Step j. Set RANGE switch to the MANUAL position. Rotate MANUAL control to the maximum ccw position. Adjust fo/fMIN control until the Frequency meter on the EMI/FI Meter indicates the same frequency as noted by the "Marker" method (Step j). Set the Δf/fMAX control to the desired sweep width. (The dial is calibrated in percentage of the selected band.) For example, the sweep range will be:

$$fo \pm \frac{\Delta f}{2}$$

Set SWEEP RANGE switch back to desired sweep position. (Step b). Depress the START switch.

SECTOR MODE

Set SCAN MODE switch to the fMIN CAL position. Vary the fo/fMIN control for the lower frequency limit of the sweep as indicated on the Frequency meter of the selected EMI/FI Meter. Set SCAN MODE switch to the fMAX CAL position. Adjust Δf/MAX control for the upper frequency limit of the sweep as indicated on the Frequency meter of the selected EMI/FI Meter. Set the SCAN MODE switch to the OPR position. Set the SWEEP RANGE switch back to desired sweep position (Step b). Actuate the START switch.

l. To determine the level of a signal of interest, a gain variation curve may be generated because the Model P-7 has calibrated the EMI/FI Meters at a single frequency only. For a single band the 1 plot-per-page mode should be used. For a multiband plot, the 8 plots-per-page mode should be used. Select all bands of the selected EMI/FI Meter. Set SWEEP RANGE switch as in Step b. Set the DETECTOR FUNCTION switch to the CAL position. Activate the RESET switch and the START switch. An X-Y recording should be initiated. (This gain variation curve is negative in value and may be retained as a reference for the condition of the tuners in the EMI/FI Meter.) This chart should be compared with the Calibration Chart in the Instruction Manual of the selected EMI/FI Meter at the specific frequencies of interest to obtain corrected calibration figures, as in the following example:

Calibration figure from EMI/FI Meter manual:	+29.50 dB
Figure from gain variation curve:	−28.75 dB
Correction factor (add algebraically):	+ 0.75 dB

Add correction factor algebraically to signal recording at frequency of interest for actual level of signal of interest. See EMI/FI Meter Instruction Manual for the use of correction factors of antennas used.

4.3.4 Time Domain Measurements

a. Set up the Model P-7 and EMI/FI Meter as in Paragraph 4.3.3 and set the controls for the MANUAL scan mode.

b. Connect a strip chart recorder to the X-Y RECORDER Y-DATA receptacle.

c. Select the band that contains the frequency of interest.

d. Vary the MANUAL control to the frequency of interest.

e. The strip chart recorder will indicate the amplitude of the frequency of interest versus time.

4.3.5 Operation by a Remote Digital Computer

a. Set all EMI/FI Meters to REMOTE control mode.

b. Set all EMI/FI Meters and the Model P-7 POWER switches to the ON position.

c. Operate the RESET switch.

d. Set the PROGRAMMER MODE switch to the REMOTE position.

e. The remote digital computer may now take over the functions of the Model P-7 Programmer.

4.3.6 Plots-per-page Format

In the X-Y RECORDER mode there are two modes of operation. In the 1 and 4 plots-per-page modes, the Programmer will plot sequentially. That is, the first depressed pushbutton (farthest left) will be plotted in the 1 plot-per-page mode (see Figure 4-3) and the first 4 depressed pushbuttons (from left to right) will be plotted in the 4 plots-per-page mode (see Figure 4-4). At the end of the last plot, the Model P-7 will automatically reset and await further commands.

The other mode of operation with the X-Y recorder involves a predetermined arrangement of the plotted data. This mode includes 8, 16 and 24 plots-per-page. Preprinted paper may be used with each of these modes and the bands, therefore, are dedicated to a position on the plotted page. The 8 plots-per-page are displayed in Figure 4-5.

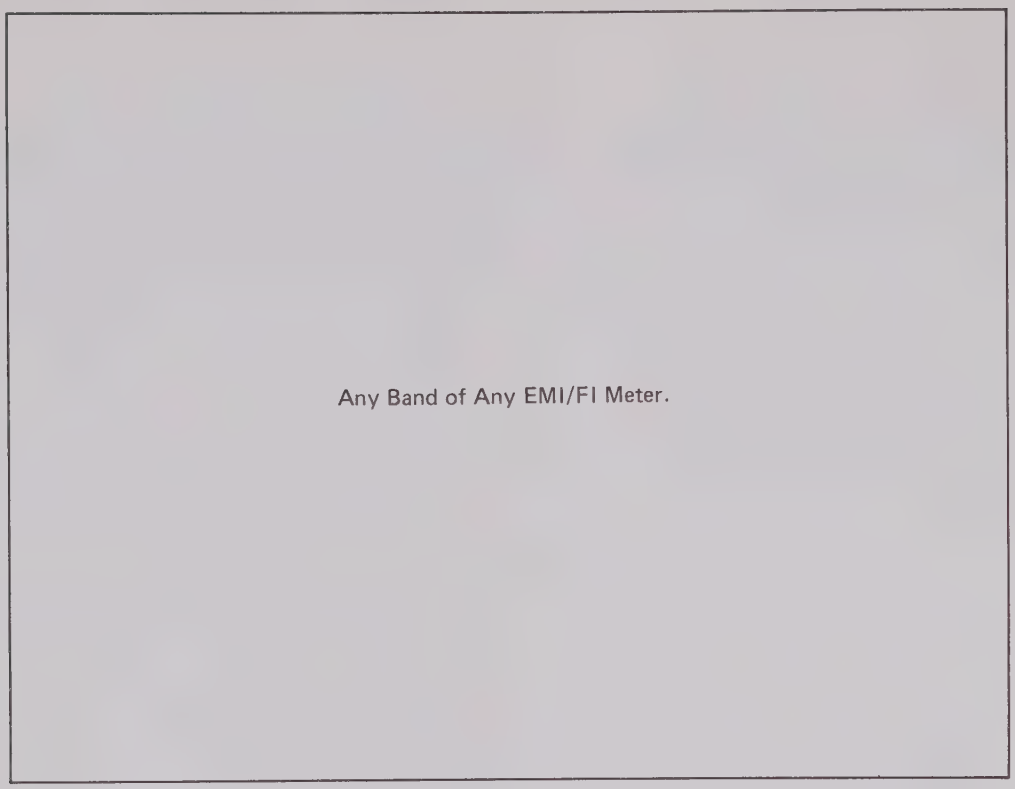


Figure 4-3. One Plot-per-page Format

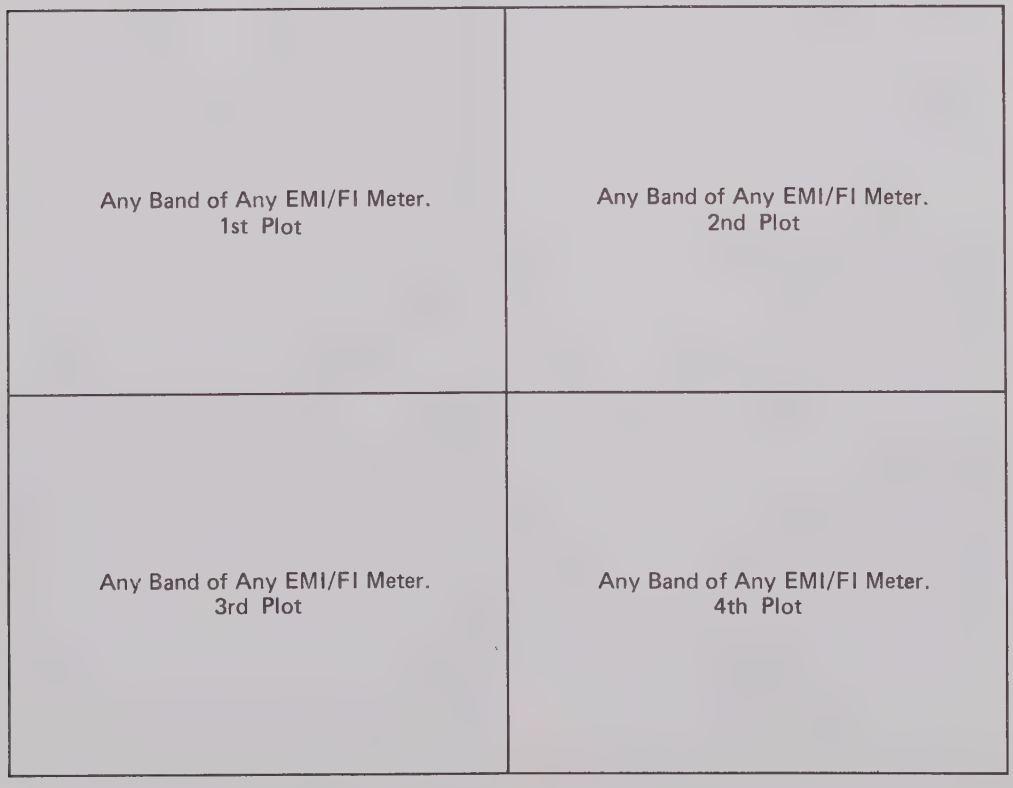
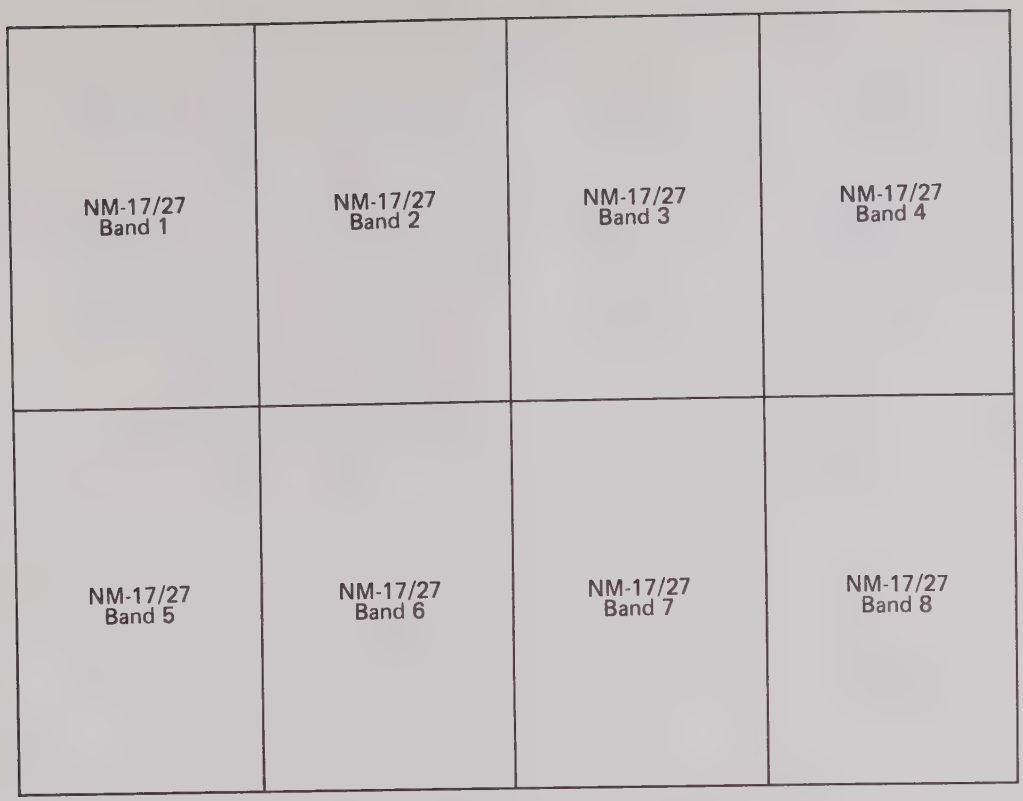

Any Band of Any EMI/FI Meter.
1st Plot
Any Band of Any EMI/FI Meter.
2nd Plot
Any Band of Any EMI/FI Meter.
3rd Plot
Any Band of Any EMI/FI Meter.
4th Plot

Figure 4-4. Four Plots-per-page Format

A.



B.

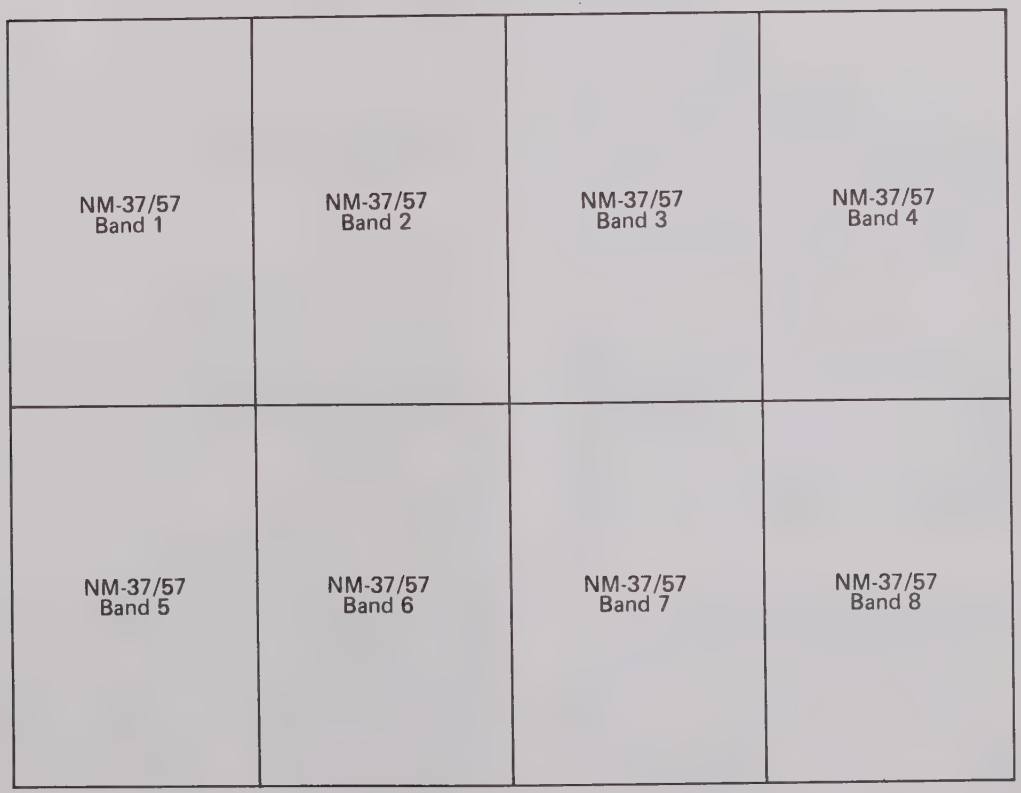


Figure 4-5. Eight Plots-per-page Format

c.

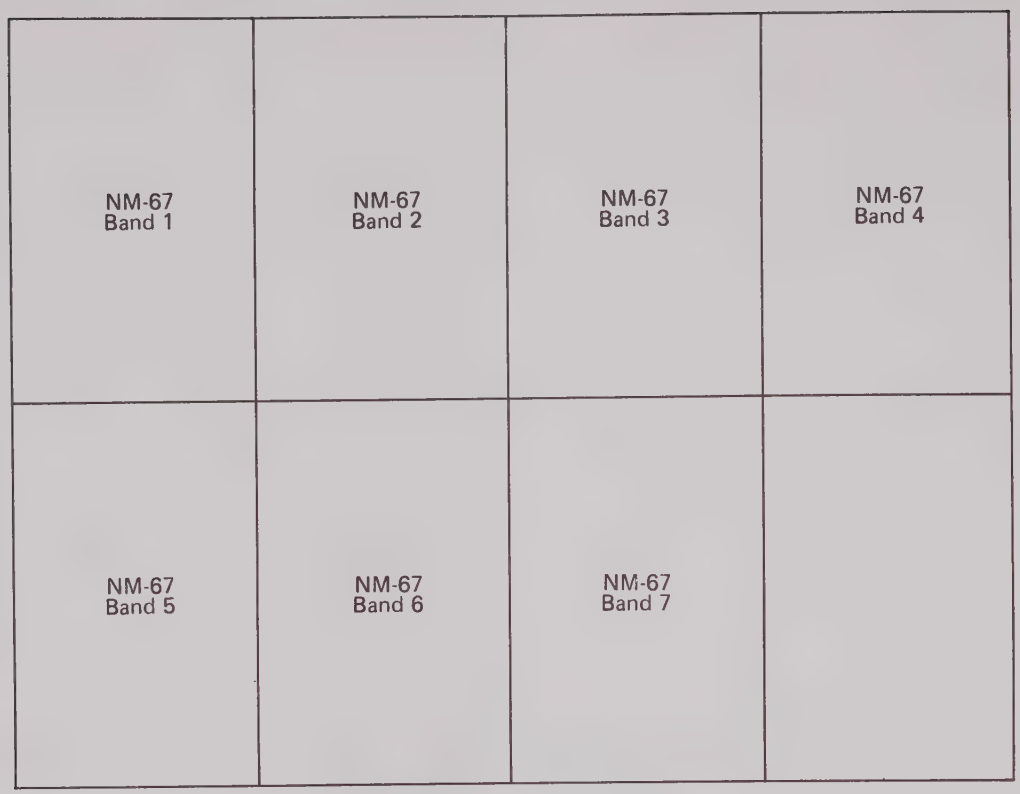


Figure 4-5. Eight Plots-per-page Format (Cont.)

Only one of the three multiband EMI/FI Meters (Models NM-17/27, NM-37/57 and NM-67) may be plotted in this mode. The EMI/FI Meter that will be plotted first is determined by the farthest left depressed pushbutton. In the 16 plots-per-page mode, only the two eight-band EMI/FI Meters (Models NM-17/27 and NM-37/57) may be plotted. The positions of the plots are displayed in Figure 4-6.

In the 24 plots-per-page mode, every band of every EMI/FI Meter is dedicated to a position on the plotted page, as displayed in Figure 4-7. In any of these plotting modes (8, 16, or 24 plots-per-page), any bands not selected will result in a blank space on the plotted page. At the end of a plotted page, the Model P-7 automatically resets and awaits further commands.

4.3.7 "Calibration" of X-Y Recorder Paper

To "calibrate" the X-Y recorder paper in amplitude and frequency set the EMI/FI Meter controls and switches as follows:

CONTROL MODE	LOCAL
FUNCTION	SLIDEBACK PEAK
ATTENUATOR dB	Fully cw
CALIBRATE	Fully ccw
BANDWIDTH	Narrowest

Set the Model P-7 controls and switches as follows:

SWEEP TIME (SEC) RANGE	3
SWEEP TIME (SEC) VERNIER	X1
SCAN MODE	FULL

Level Markers:

Set the DISPLAY MODE switch to number of bands to be calibrated. Activate the Band Select switches for the bands to be calibrated. Vary the SLIDEBACK PEAK control for the desired dB level (e.g. 10 dB steps) as indicated by the Output meter of the EMI/FI Meter. Activate the RESET switch. Activate the START switch. The recorder should plot the selected dB level. Repeat the above procedure for other level markers desired by reactivating the START switch.

Frequency Markers:

Set the EMI/FI Meter CONTROL MODE switch to REMOTE and the Model P-7 SWEEP TIME RANGE switch to MANUAL. Depress the START switch and vary the MANUAL control to the desired frequency as noted on the Frequency meter of the selected EMI/FI Meter. Set the EMI/FI Meter CONTROL MODE switch to LOCAL and adjust the SLIDEBACK control for some reference level on the Output meter (e.g.: 0 dB). Set the PEN switch to the DOWN position and rotate the SLIDEBACK control fully cw. Set the PEN switch to the UP position. Repeat the above for all desired frequency references desired. Set the EMI/FI Meter CONTROL MODE switch to the REMOTE position and reset the SWEEP TIME RANGE switch as in Paragraph 4.3.3-b.

NM-17/27 Band 1	NM-17/27 Band 2	NM-17/27 Band 3	NM-17/27 Band 4
NM-17/27 Band 5	NM-17/27 Band 6	NM-17/27 Band 7	NM-17/27 Band 8
NM-37/57 Band 1	NM-37/57 Band 2	NM-37/57 Band 3	NM-37/57 Band 4
NM-37/57 Band 5	NM-37/57 Band 6	NM-37/57 Band 7	NM-37/57 Band 8

Figure 4-6. Sixteen Plots-per-page Format

NM-7	NM-17/27 Band 1	NM-17/27 Band 2	NM-17/27 Band 3	NM-17/27 Band 4	NM-17/27 Band 5
NM-17/27 Band 6	NM-17/27 Band 7	NM-17/27 Band 8	NM-37/57 Band 1	NM-37/57 Band 2	NM-37/57 Band 3
NM-37/57 Band 4	NM-37/57 Band 5	NM-37/57 Band 6	NM-37/57 Band 7	NM-37/57 Band 8	NM-67 Band 1
NM-67 Band 2	NM-67 Band 3	NM-67 Band 4	NM-67 Band 5	NM-67 Band 6	NM-67 Band 7

Figure 4-7. Twenty-four Plots-per-page Format

Table 4-2. Program Receptacle Pin Data (J18, J21, J24, & J27)

Pin	Function
A	Relay contact closure applies −12 V from Models NM-7, NM-17/27, NM-37/57 and NM-67 EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 1 of all EMI/FI Meters
B	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 2 of Models NM-17/27, NM-37/57, NM-67
C	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 3 of Models NM-17/27, NM-37/57, NM-67
D	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 4 of Models NM-17/27, NM-37/57, NM-67
E	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 5 of Models NM-17/27, NM-37/57, NM-67
F	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 6 of Models NM-17/27, NM-37/57, NM-67
G	Not used
H	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 7 of Models NM-17/27, NM-37/57, NM-67
J	+12 V from EMI/FI Meters when the EMI/FI Meters are in the REMOTE control mode to provide the voltage switched to pins a, b, c, d, f and g of this receptacle.
K	Relay contact closure applies −12 V from EMI/FI Meters via pin N of this receptacle back to the EMI/FI Meters to select band 8 of Models NM-17/27 and NM-37/57
L	Provides 0 V to +10 V to tune selected EMI/FI Meter
M	Relay contact closure applies +12 V from EMI/FI Meters via pin X of this receptacle to select bandwidth No. 1 in all EMI/FI Meters
N	−12 V from Models NM-7, NM-17/27, NM-37/57 and NM-67 EMI/FI Meters when EMI/FI Meters are in REMOTE control mode to provide the voltage switched at pins A, B, C, D, E, F, H and K of this receptacle
P	Relay contact closure applies +12 V from EMI/FI Meters via pin X of this receptacle to select bandwidth No. 2 in all EMI/FI Meters
R	Not used
S	Relay contact closure applies +12 V from EMI/FI Meters via pin X of this receptacle to select bandwidth No. 3 in all EMI/FI Meters
T	0.1 V to +10 V from the EMI/FI Meters representing the frequency. These are selected in the Model P-7 and applied to the REMOTE DIGITAL DISPLAY UNIT receptacle, J36-P (See operator's manual for specific voltages)
U	Provides dc ground between EMI/FI Meters and the Model P-7
V	−10 mV to +120 mV from the EMI/FI Meters representing the weighted dB readout. These are selected in the Model P-7 and applied to the REMOTE DIGITAL DISPLAY UNIT receptacle, J36-S
W	Relay contact closure applies +12 V from EMI/FI Meters via pin X of this receptacle to select bandwidth No. 4 in the Model NM-17/27
X	+12 V from EMI/FI Meters when EMI/FI Meters are in REMOTE control mode to provide the voltage switched at pins M, P, S and W of this receptacle
Y	0 V to +2 V from EMI/FI Meters representing the Y-data
Z	Not used

Table 4-2. Program Receptacle Pin Data (J18, J21, J24, & J27) (Cont.)

Pin	Function
a	Relay closure applies +12 V from EMI/FI Meters via pin J of this receptacle to select PEAK 3.0 SEC detector function in all EMI/FI Meters
b	Relay closure applies +12 V from EMI/FI Meters via pin J of this receptacle to select PEAK 0.3 SEC detector function in all EMI/FI Meters
c	Relay closure applies +12 V from EMI/FI Meters via pin J of this receptacle to select PEAK 0.05 SEC detector function in all EMI/FI Meters
d	Relay closure applies +12 V from EMI/FI Meters via pin J of this receptacle to select QP detector function in all EMI/FI Meters
e	Not used
f	Relay closure applies +12 V from EMI/FI Meters via pin J of this receptacle to select Fl detector function in all EMI/FI Meters
g	Relay closure applies +12 V from EMI/FI Meters via pin J of this receptacle to select CAL detector function in all EMI/FI Meters
h	Not used
i	Not used
j	Provides 0 V to +10 V to the Models NM-37/57 and NM-67 and 0 V to −10 V to the Models NM-7 and NM-17/27 for remote calibration of the EMI/FI Meters by the Model P-7 CAL controls
k	0 V to +2 V Fl information from the EMI/FI Meters. These are selected in the Model P-7 and appear at the SIMULTANEOUS Fl receptacle of the Model P-7. (When the DETECTOR FUNCTION switch of the Model P-7 is in the PEAK mode)
m	Not used
n	Not used
p	Not used
q	Not used
r	Not used
s	Not used
t	Not used

Table 4-3. Remote Digital Controller Receptacle Pin Data (J29)

Pin	Function
A	0 V to −10 V sweep voltage output from Model P-7. May be externally connected to pin B of this receptacle if sweep voltage of Model P-7 is desired to sweep EMI/FI Meters instead of remote digital controller.
B	0 V to −10 V remote tuning voltage input to Model P-7. May be connected to pin A of this receptacle if remote digital controller tuning is not desired.
C	0 V input to Model P-7 will lower the pen of an X-Y recorder. Otherwise, +5 V appears on this pin.
D	O V to −10 V input to Model P-7 for remote X-Y recorder and CRT X-axis position. O V represents left side of page, −10 V represents right side of page. (May be connected to pin A of this receptacle if built-in sweep voltage of Model P-7 is desired.)

Table 4-3. Remote Digital Controller Receptacle Pin Data (J29) (Cont.)

Pin	Function
E	Not used
F	0 V input of Model P-7 to remotely select band 1 of Model NM-7. Otherwise +5 V appears at this pin.
G	0 V input to Model P-7 to remotely select band 1 of Model NM-17/27. Otherwise +5 V appears at this pin.
H	0 V input to Model P-7 to remotely select band 2 of Model NM-17/27. Otherwise +5 V appears at this pin.
J	0 V input to Model P-7 to remotely select band 3 of Model NM-17/27. Otherwise +5 V appears at this pin.
K	0 V input to Model P-7 to remotely select band 4 of Model NM-17/27. Otherwise +5 V appears at this pin.
L	0 V input to Model P-7 to remotely select band 5 of Model NM-17/27. Otherwise +5 V appears at this pin.
M	0 V input to Model P-7 to remotely select band 6 of Model NM-17/27. Otherwise +5 V appears at this pin.
N	0 V input to Model P-7 to remotely select band 7 of Model NM-17/27. Otherwise +5 V appears at this pin.
P	0 V input to Model P-7 to remotely select band 8 of Model NM-17/27. Otherwise +5 V appears at this pin.
R	0 V input to Model P-7 to remotely select band 1 of Model NM-37/57. Otherwise +5 V appears at this pin.
S	0 V input to Model P-7 to remotely select band 2 of Model NM-37/57. Otherwise +5 V appears at this pin.
T	0 V input to Model P-7 to remotely select band 3 of Model NM-37/57. Otherwise +5 V appears at this pin.
U	0 V input to Model P-7 to remotely select band 4 of Model NM-37/57. Otherwise +5 V appears at this pin.
V	0 V input to Model P-7 to remotely select band 5 of Model NM-37/57. Otherwise +5 V appears at this pin.
W	0 V input to Model P-7 to remotely select band 6 of Model NM-37/57. Otherwise +5 V appears at this pin.
X	0 V input to Model P-7 to remotely select band 7 of Model NM-37/57. Otherwise +5 V appears at this pin.
Y	0 V input to Model P-7 to remotely select band 8 of Model NM-37/57. Otherwise +5 V appears at this pin.
Z	0 V input to Model P-7 to remotely select band 1 of Model NM-67. Otherwise +5 V appears at this pin.
a	0 V input to Model P-7 to remotely select band 2 of Model NM-67. Otherwise +5 V appears at this pin.
b	0 V input to Model P-7 to remotely select band 3 of Model NM-67. Otherwise +5 V appears at this pin.
c	0 V input to Model P-7 to remotely select band 4 of Model NM-67. Otherwise +5 V appears at this pin.
d	0 V input to Model P-7 to remotely select band 5 of Model NM-67. Otherwise +5 V appears at this pin.
e	0 V input to Model P-7 to remotely select band 6 of Model NM-67. Otherwise +5 V appears at this pin.
f	0 V input to Model P-7 to remotely select band 7 of Model NM-67. Otherwise +5 V appears at this pin.
g	0 V input to Model P-7 to remotely select the Fl detector function. Otherwise +5 V appears at this pin.
h	0 V input to Model P-7 to remotely select the QP detector function. Otherwise +5 V appears at this pin.
i	0 V input to Model P-7 to remotely select the PEAK 0.05 SEC detector function. Otherwise +5 V appears at this pin.
j	0 V input to Model P-7 to remotely select the PEAK 0.3 SEC detector function. Otherwise +5 V appears at this pin.
k	0 V input to Model P-7 to remotely select the PEAK 3.0 SEC detector function. Otherwise +5 V appears at this pin.
m	0 V input to Model P-7 to remotely select the CAL function. Otherwise +5 V appears at this pin.

Table 4-3. Remote Digital Controller Receptacle Pin Data (J29) (Cont.)

Pin	Function
n	0 V input to Model P-7 to remotely select the BANDWIDTH No. 1. Otherwise +5 V appears at this pin.
p	0 V input to Model P-7 to remotely select the BANDWIDTH No. 2. Otherwise +5 V appears at this pin.
q	0 V input to Model P-7 to remotely select the BANDWIDTH No. 3. Otherwise +5 V appears at this pin.
r	0 V input to Model P-7 to remotely select the BANDWIDTH No. 4. Otherwise +5 V appears at this pin.
s	0 V input to Model P-7 to remotely select the remote attenuator 0 dB function. Otherwise +5 appears at this pin.
t	0 V input to Model P-7 to remotely select the remote attenuator 20 dB function. Otherwise +5 V appears at this pin.
u	0 V input to Model P-7 to remotely select the remote attenuator 40 dB function. Otherwise +5 V appears at this pin.
v	0 V input to Model P-7 to remotely select the remote attenuator 60 dB function. Otherwise +5 V appears at this pin.
w	0 V input to Model P-7 to remotely select the remote attenuator 80 dB function. Otherwise +5 V appears at this pin.
x	0 V input to Model P-7 to remotely select the remote attenuator 100 dB function. Otherwise +5 V appears at this pin.
y	0 V input to Model P-7 to remotely select the 4 plot-per-page function. Otherwise +5 V appears at this pin.
z	0 V input to Model P-7 to remotely select the 1 plot-per-page function. Otherwise +5 V appears at this pin.
AA	0 V input to Model P-7 to remotely select the 16 plot-per-page function. Otherwise +5 V appears at this pin.
BB	0 V input to Model P-7 to remotely select the 8 plot-per-page function. Otherwise +5 V appears at this pin.
CC	0 V input to Model P-7 to remotely select the 24 plot-per-page function. Otherwise +5 V appears at this pin.
DD	0 V input to Model P-7 to remotely select the START function. Otherwise +5 V appears at this pin.
EE	0 V input to Model P-7 to remotely select the STOP function. Otherwise +5 V appears at this pin.
FF	0 V input to Model P-7 to remotely select the RESET function. Otherwise +5 V appears at this pin.
GG	When the PROGRAMMER MODE switch of the Model P-7 is in the LOCAL position this pin is open-circuited; in the REMOTE position, this pin is grounded, enabling the remote digital controller.
HH	Provides dc ground between Model P-7 and digital controller unit.

Table 4-4. Antenna Switch and Attenuator (Input Unit) Receptacle Pin Data (J30)

Pin	Function
A	BCD output (2^0) to select proper remote antenna for the EMI/FI Meter selected. Open collector logic. Format defined in Table 4-6.
B	BDC output (2^1) to select proper remote antenna for the EMI/FI Meter selected. Open collector logic. Format defined in Table 4-6.
C	BCD output (2^2) to select proper remote antenna for the EMI/FI Meter selected. Open collector logic. Format defined in Table 4-6.

Table 4-4. Antenna Switch and Attenuator (Input Unit) Receptacle Pin Data (J30) (Cont.)

Pin	Function
D	BCD output (2^3) to select proper remote antenna for the EMI/FI Meter selected. Open collector logic. Format defined in Table 4-6.
E	BCD output (2^4) to select proper remote antenna for the EMI/FI Meter selected. Open collector logic. Format defined in Table 4-6.
F	Not used
G	0 V output selects the 0 dB position of the remote attenuator. Open collector logic. (This is grounded in the Model 1U-7A for use as an interlock for the Model DDU-7)
H	0 V output selects the 20 dB position of the remote attenuator. Open collector logic.
J	0 V output selects the 40 dB position of the remote attenuator. Open collector logic.
K	0 V output selects the 60 dB position of the remote attenuator. Open collector logic.
L	0 V output selects the 80 dB position of the remote attenuator. Open collector logic.
M	0 V output selects the 100 dB position of the remote attenuator. Open collector logic.
N	Not used.
P	Not used.
R	Not used.
S	+15 V output for test purposes.
T	–15 V output for test purposes.
U	+5 V output for test purposes.
V	Provides dc ground between Model P-7 and remote antenna and attenuator unit.

Table 4-5. Remote Digital Display Unit Receptacle Pin Data (J36)

Pin	Function
A	BCD output (2^0) to select the frequency readout decimal point and frequency indicator lamps (kHz, MHz & GHz). Open collector logic. See Table 4-6 for format.
B	BCD output (2^1) to select the frequency readout decimal point and frequency indicator lamps (kHz, MHz & GHz). Open collector logic. See Table 4-6 for format.
C	BCD output (2^2) to select the frequency readout decimal point and frequency indicator lamps (kHz, MHz & HGz). Open collector logic. See Table 4-6 for format.
D	BCD output (2^3) to select the frequency readout decimal point and frequency indicator lamps (kHz, MHz & GHz). Open collector logic. See Table 4-6 for format.
E	BCD output (2^4) to select the frequency readout decimal point and frequency indicator lamps (kHz, MHz & GHz). Open collector logic. See Table 4-6 for format.
F	0 V to +2 V output representing the multiplexed Y-data from the EMI/FI Meters.
G	0 V output for 0 dB scaling factor to correct the dB readout when the system is used with a remote attenuator. Open collector logic.
H	0 V output for 20 dB scaling factor to correct the dB readout when the system is used with a remote attenuator. Open collector logic.

Table 4-5. Remote Digital Display Unit Receptacle Pin Data (J36) (Cont.)

Pin	Function
J	O V output for 40 dB scaling factor to correct the dB readout when the system is used with a remote attenuator. Open collector logic
K	0 V output for 60 dB scaling factor to correct the dB readout when the system is used with a remote attenuator. Open collector logic.
L	0 V output for 80 dB scaling factor to correct the dB readout when the system is used with a remote attenuator. Open collector logic.
M	0 V output for 100 dB scaling factor to correct the dB readout when the system is used with a remote attenuator. Open collector logic.
N	−400 mV to +1.2 V output to control the dB readout of the Digital Display Unit. (See Instruction Manual of selected EMI/FI Meter for actual voltages.)
P	0 V to +10 V output to the frequency readout of the Digital Display Unit.
R	0 V input to remotely select the STOP function. Otherwise +5 V appears at this pin.
S	+15 V output for test purposes.
T	−15 V output for test purposes.
U	Not used.
V	Provides dc ground between Model P-7 and Digital Display Unit.

Table 4-6. BCD Output Format

EMI/FI Meter	2^4	2^3	2^2	2^1	2^0
NM-7	0	0	0	0	0
NM-17/27	0	0	0	0	1
	0	0	0	1	0
	0	0	0	1	1
	0	0	1	0	0
	0	0	1	0	1
	0	0	1	1	0
	0	0	1	1	1
	0	1	0	0	0
NM-37/57	0	1	0	0	1
	0	1	0	1	0
	0	1	0	1	1
	0	1	1	0	0
	0	1	1	0	1
	0	1	1	1	0
	0	1	1	1	1
	1	0	0	0	0
NM-67	1	0	0	0	1
	1	0	0	1	0
	1	0	0	1	1
	1	0	1	0	0
	1	0	1	0	1
	1	0	1	1	0
	1	0	1	1	1
Auto Reset	1	1	0	0	0

Section V
THEORY OF OPERATION

5.1 INTRODUCTION

This section of the manual contains the theory of operation of the Model P-7 Programmer. The information is related to the Simplified Block Diagram, Figure 5-1, and Functional and Detailed Block Diagrams contained in this section. The circuit analysis information is presented primarily for the benefit of the technician to troubleshoot and repair the equipment.

5.2 BASIC PRINCIPLES OF OPERATION

The Model P-7 Programmer is capable of controlling up to four separate EMI/FI Meters covering the frequency range of 20 Hz to 18 GHz. Each EMI/FI Meter is divided into either 8 bands, 7 bands*, or one band, with a total of 24 bands for all four EMI/FI Meters. The Model P-7 Programmer will sweep through a sequence of these 24 bands, omitting the bands not selected by the operator. The bands displayed however, are affected by the position of the DISPLAY MODE switch, which is explained in Paragraph 5.2.1. The Model P-7 Programmer controls the scan mode: full band or sector scan, and also the sweep time from 30 ms/band to 300 s/band. The operator of the Model P-7 Programmer can also control the bandwidth, detector, and calibration functions of the four EMI/FI Meters and control a remote attenuator antenna switch, (Input Unit, Model IU-7A). The Model P-7 Programmer multiplexes several outputs from the EMI/FI Meters, passing only the signal from the EMI/FI Meter being swept at that time. The CRT Y-data, X-Y recorder Y-data, frequency data, simultaneous FI data and the weighted dB data are derived from these multiplexed EMI/FI Meter data lines. Capability of interfacing with a Digital Display Unit, Model DDU-7, and a digital controller has been provided. This enables the Model P-7 to be programmed and data to be stored in external digital equipment.

5.2.1 Band Selection

The band selection is accomplished by the Logic Control, A10, Band Decoder and Band Selector, A5, A6, A7, Digital Interface Circuits, A11, and the START, RESET, Band Select and DISPLAY MODE switches. See Figure 5-1. When a Band Select switch is depressed, the lamp within the pushbutton becomes half-illuminated which indicates that a logic signal is being sent to the band decoder via the Digital Interface, Digital Multiplexer and Logic Control. The logic control is initiated by activating the START switch. The logic control includes a band counter that controls the band decoder. When a depressed Band Select switch is decoded, the band counter is stopped and a sweep is initiated. At this time the Band Select switch for the selected band being swept becomes fully illuminated. The sweep voltage is gated by Analog Multiplexer, A8, via Coincidence Gate, A15, to the EMI/FI Meter being swept and the proper band is selected in the EMI/FI Meter. After that band has been swept, the lamp will return to its half-illuminated condition.

The number of bands that will be decoded and swept is determined by the DISPLAY MODE switch position and the Band Select switch positions. The DISPLAY MODE switch determines the number of plots-per-page that will be recorded on a single page with one plot occurring for each selected band.

*See Table 4-1 Items 22 thru 28 for details.

When one plot per page is selected, only the first depressed Band Select switch that is decoded will be plotted. Since the control logic searches the Band Select switches from left to right (via the band decoder), the farthest left Band Select switch that is depressed will be the only band selected and swept by the Programmer. When the plot is completed, the Programmer resets and awaits further operator action.

If four plots-per-page is selected, the first four depressed Band Select push-buttons to the left will determine the four bands that are to be swept. Refer to Figure 4-4 for position of the plots. If three or less Band Select switches are depressed, only the number of depressed switches will be plotted. When the plot has been completed, the Programmer will be automatically reset to the conditions prior to plotting.

The eight plots-per-page mode is intended for use with preprinted graph paper. For this reason, only one EMI/FI Meter may be plotted at a time. (The single band EMI/FI Meter, Model NM-7, is disabled (even if Band Select switch is depressed) in the eight or sixteen plots-per-page modes.) Each position on the plotted page is dedicated to a specific band (See Figures 4-5 a, b and c for position of the plots.) The Programmer will only scan bands in the same EMI/FI Meter as the first detected band (farthest left of the depressed switches). When the last depressed band of this EMI/FI Meter has been decoded, the Programmer resets. The undepressed bands of the EMI/FI Meter are not plotted and their positions on the page are left blank.

The operation of sixteen plots-per-page is similar to that of eight plots-per-page. The bands are dedicated to positions on the plotted page, but only the Model NM-17/27 and Model NM-37/57 EMI/FI Meters may be plotted in this mode. Undepressed switches are left blank and automatic reset occurs after the last depressed band of the Model NM-37/57 EMI/FI Meter has been swept.

The twenty-four-plots-per-page mode dedicates a position of the plotted page for each of the twenty-four bands. Any combinations of bands may be plotted from any or all of the EMI/FI Meters. Automatic reset occurs after the last depressed band has been swept.

In the CRT display mode, only the first detected band (farthest left) is swept. At the end of the sweep a reset and an automatic start occur. The same band is then decoded and swept again. This process continues until the RESET switch is depressed.

Operating the RESET switch interrupts the band count and returns the Model P-7 to the starting conditions. To proceed to the next band, the previously-swept Band Select switch must be de-energized.

5.2.2 Display Mode Control

Display Mode control is accomplished by the Digital Pen Control, A12, Sweep Select, A14, and Digital-to-Analog Converter circuits, A2, and the DISPLAY MODE, SCAN MODE and X-Y RECORDER switches. The Digital Pen Control circuit sends digital control signals to the Digital-to-Analog converter according to the position of the DISPLAY MODE switch. The Digital-to-Analog Converter

converts these digital command signals to analog offset voltages for proper location of the band plots on the graph paper. The sweep range (X data) is determined by the SCAN MODE switch. The Digital-to-Analog Converter scales the X and Y data according to the DISPLAY MODE switch position, and sums the scaled data and offset voltages. The properly scaled and level-shifted X and Y data are then connected to the X-Y RECORDER X DATA and Y DATA output receptacles via slew rate limiting circuits. The slew rate limitation is applied when the pen is lifted, to slow down the retrace of the pen, while keeping the high slew rate during recording.

Zero and sensitivity controls of the X-Y recorder connected to the Model P-7 can be set when the X-Y RECORDER switch is set to the ZERO CAL and the MAX CAL positions.

5.2.3 Pen Control

The pen control is accomplished by the PEN switch and pen control circuits, A13 and A14, and is also associated with the logic control circuitry, A10. When the PEN switch is in the NORMAL position, the pen drops when plotting and lifts when a plot is completed. A three-second delay is generated between band selection and pen drop to enable the pen to reach the proper position. The pen remains up in any of four operated conditions, as follows: when the SWEEP TIME RANGE switch is in the MANUAL position, when the DISPLAY MODE switch is in the CRT position, when the STOP switch is depressed, and when the RESET switch is depressed. The pen may be lowered or raised at any time by the action of the PEN switch. The pen control circuit also operates the Z BLANK output for CRT display.

5.2.4 Scan Control

Scan control is accomplished by the Sweep Generator circuit A1, the SWEEP TIME RANGE and SCAN MODE switches, and the MANUAL and VERNIER control. Two basic scan modes are available: automatic scan and a manual scan.

The automatic scan mode is operational when the SWEEP TIME RANGE switch is in any position except the MANUAL position. When the band decoder detects a depressed Band Select switch, the logic control stops the band count and initiates a 0 to +10 V linear sweep to scan the selected band. The sweep time is determined by the SWEEP TIME RANGE switch and VERNIER control. The sweep starts on a command signal from the Logic Control circuit, A10. When the STOP switch is activated, the sweep generator stops and holds the tuning voltage constant (within leakage) until the STOP switch is deactivated. When the STOP switch is activated, the sweep continues.

The SCAN MODE switch controls the tuning voltage applied to the selected EMI/FI Meter. In the FULL position of the SCAN MODE switch the full 0 to +10 V scan will be applied to the selected EMI/FI Meter. In the Δf position of the SCAN MODE switch,

$$\pm \frac{\Delta V}{2}$$

scan voltage will be added to a fixed Vo voltage, resulting in a sweep from

$$fo - \frac{\Delta f}{2} \text{ to } fo + \frac{\Delta f}{2}.$$

In the SECTOR position of the SCAN MODE switch the tuning voltage will scan from Vmin to Vmax, resulting in a sweep from fMIN to fMAX. ΔV, Vo, Vmin and Vmax can be adjusted by the Δf/fMAX and fo/fMIN controls and read directly in percent of the selected band.

where ΔV corresponds to Δf
and Vo corresponds to fo (the center frequency)
Vmin corresponds to fMIN
Vmax corresponds to fMAX

Manual scan can be achieved by placing the SWEEP TIME RANGE switch in the MANUAL position. In this case the sweep generator is disabled and the output from the MANUAL control is substituted for the sweep generator and processed in the same manner.

5.2.5 Bandwidth Selection

The bandwidth selection is accomplished by the Relay Driver circuit, A3, associated with the BANDWIDTH switch. The relay drivers are operated by the BANDWIDTH switch and the relays connect +12 V from the selected EMI/FI Meter to one of the four bandwidth lines.

5.2.6 Detector Function Selection

The detector function selection is accomplished by the Relay Driver circuit, A4, part of A9, and the DETECTOR FUNCTION switch. The relay drivers are operated by the DETECTOR FUNCTION switch and the relays connect +12 V from the selected EMI/FI Meter to one of six detector function lines. When the DETECTOR FUNCTION switch is in the CAL position, the gain of the selected EMI/FI Meter can be adjusted by means of four screwdriver-adjusted potentiometers, located on the front panel of the Model P-7. The gain control is achieved by adjusting the bias voltage applied to the calibration line. The bias voltage source is located on assembly A15.

5.2.7 Data Multiplexing

Six unique data lines from each EMI/FI Meter are multiplexed by the Analog Multiplexer Circuit, A8, and by the Auxiliary Multiplexer circuit, A13. Analog Multiplexer Circuit, A8, contains the Log Video multiplexer used for CRT Y data, and the Y Voltage Multiplexer, used for X-Y Recorder Y data. The Simultaneous FI data and dB Readout data multiplexers are also located on A8. The Frequency Readout data and Auxiliary Output data multiplexers are on assembly A13. The Multiplexer circuits are controlled by the Receiver Decoder circuit, A9. The CRT X data is level-shifted on assembly A1.

To determine the frequency of a signal in the CRT display mode, the Analog Multiplexer circuit, A8, contains a marker generator, operated by a comparator. The comparator compares the manual tuning voltage with the ramp voltage of the sweep generator. The instant that the ramp voltage exceeds the manual tuning voltage, the comparator output changes state and a one-shot multivibrator generates a negative-going marker blip, which is connected to the CRT Y DATA output receptable.

5.2.8 Attenuator-Antenna Switch Control

The Remote Attenuator in the Model IU-7A is controlled by the REMOTE ATTENUATOR switch of the Model P-7 via buffer circuits, located on assemblies A13 and A16. The Antenna switches in the Model IU-7A are controlled by binary signals through buffer circuits on assembly A15.

5.2.9 Digital Display Control

The Digital Display Unit, DDU-7, is intended for use with either digital storage devices or for the display of EMI/FI Meter signals. The signals present at the DIGITAL DISPLAY receptacle follow: multiplexed frequency, multiplexed weighted dB, multiplexed Y data, attenuation selection (6 lines). and band code (5 lines). The frequency and signal level data for the Model DDU-7 are multiplexed on assemblies A13 and A8, respectively. The unit indication

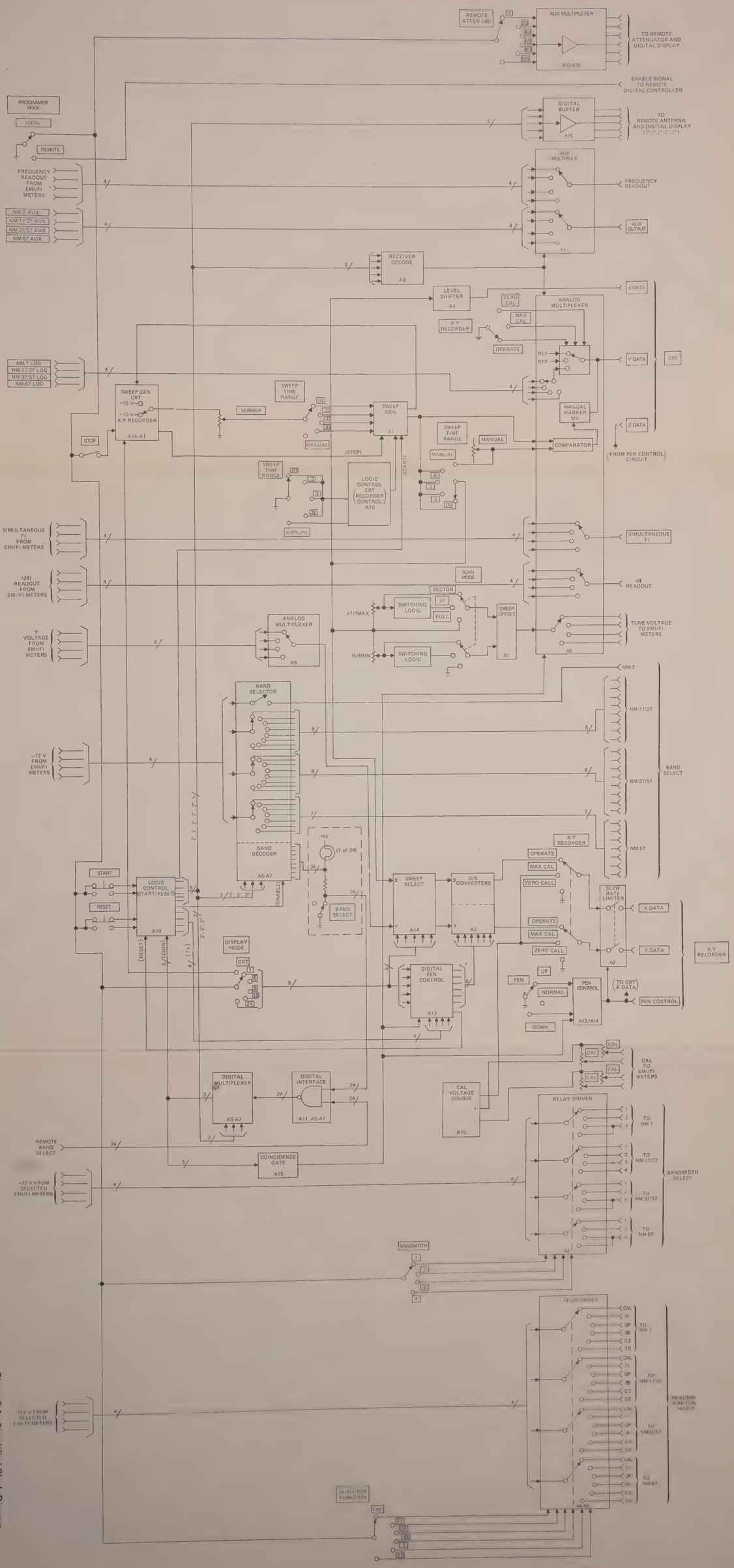


Figure 5-1. Simplified Block Diagram, Model P-7

(kHz, MHz, GHz) and the decimal point of the frequency display are controlled by digital signals from assembly A15.

5.2.10 Digital Controller Interface

Every function on the control panel (excluding X-Y RECORDER and POWER switches) have a logical OR capability. When the Programmer is in the REMOTE mode, these controls are derived from the DIGITAL CONTROLLER receptacle through the Digital Interface circuit, A11, and through gates on assemblies A3 thru A7, A9, A10, A12 thru A14, and A16. The sweep is also derived from the digital controller. Data may be sent and returned through the digital controller for total digital programming and recording.

5.3 DETAILED CIRCUIT ANALYSIS

5.3.1 Band Selection Circuitry

To facilitate understanding the operation, a Functional Block Diagram Band Selection Circuitry, Figure 5-2, is included. The Functional Block Diagram shows the selection of one specific band, Band 1. The operation of the band selection circuitry is explained in accordance with the Detailed Block Diagram Band Selection Circuitry, Figure 5-3.

The band selection circuitry is located on the Band Decoder and Multiplexer assemblies, A5, A6, A7, and on the Digital Interface assembly, A11. It is controlled by the Band Select switches S2 thru S26 and is associated with DISPLAY MODE switch, S30, and PROGRAMMER MODE switch, S37.

Binary coded band select signals 2^0, 2^1, 2^2 are provided by the Logic Control circuit, A10, and temporarily stored in the 4 bit bistable latch, A5U6. When the Strobe and Enable signals arrive from the Logic Control circuit, A10, the binary signals will be sent to the 3 to 8 lines Band Decoder, A5U3. Each output of the Decoder is connected to a relay, K1 thru K8, via a Hex Buffer Driver, A5U4, A5U5, and to a transistor switch, Q1 thru Q8, via a Hex Inverter, A5U1 and A5U2. The relays connect −12 V from the EMI/FI Meter to the selected band. When a band is programmed by Band Select switch, S2 thru S25, +5 V is applied to the indicator lamp, DS2 thru DS25, through a resistor, R9 thru R32, which limits the current to light the lamp dimly. When the band is turned on, the transistor switch short circuits the limiting resistor and the indicator lamp becomes fully illuminated.

The Band Select switches are gated by dual input NAND gates, A11U1, A11U2, and A5U8 to Digital Multiplexer, A5U7. The binary-coded band select signals 2^0,2^1,2^2, are also fed into the Digital Multiplexer, A5U7. When they coincide with a programmed band, a coincidence signal appears at the output of A5U7. The coincidence signals are connected to the Logic Control circuit, A10, and through a triple NAND gate A15U2 to the Analog Multiplexers, A8, A13, and to the Digital Pen Control circuit, A12. The coincidence signal stops the band count in the Logic Control circuit, A10, and initiates a sweep in the Sweep Generator circuit, A1.

The Detailed Block Diagram, Figure 5-3, contains all three Band Decoder and Selector assemblies A5 thru A7, which, when commanded by signals from the Logic Control circuit, A10, select one of the 24 bands, as described above.

When the PROGRAMMER MODE switch of the Model P-7 is in the REMOTE position, the band selection of the Model P-7 is disabled and is operated by the Remote Digital Controller via Digital Interface circuit, A11.

5.3.2 Reset Circuitry

Refer to the Functional Block Diagram Reset Circuit, Figure 5-4, and Detailed Block Diagram Reset, Start, Stop, Sweep Circuitry, Figure 5-5.

The reset circuitry is located on Logic Control assembly A10, Digital Pen Control assembly A12, and Sweep Select assembly A14. It is operated by RESET switch, S27, and is associated with PROGRAMMER MODE switch, S37.

Activating the RESET switch causes a level change at the inputs of gates A10U5A and A10U5B (pins A10-3 and A10-D). The input of A10U5A will go high and the input of A10U5B will go low when the switch is depressed. The input of A10U5A will go low and the input of A10U5B will go high when this switch is released. The two gates form a bounce-free switch, creating a single negative pulse at A10U5A-3.

A logical OR function is provided by the two input NAND gate A10U5D. Pin 12 of the gate is connected to Reset from the Remote Digital Controller and pin 13 is connected to the output of A10U5A (control panel RESET function). If either of these inputs go low, the output of A10U5D goes high and triggers A10U12A, a monostable multivibrator. The negative going output pulse of the multivibrator is transmitted to all flip-flops, counters and sweep generating circuitry, forcing all functions to their initial states. It resets all flip-flops, resets and reloads all counters, and retraces the sweep.

In addition to the programmed reset functions, there are two internally generated reset signals. These two reset signals are gated by A10U5C, then inverted by A14U6E and connected to A10U12A, where they trigger the reset one-shot. The inputs to dual gate A10U5C are derived from inverter A12U17B and from dual input gate A10U14B. The output of inverter A12U17B indicates when the last plot on a page has been accomplished. This may be after any number of plots, or none in some cases. The signal is controlled by the position of the DISPLAY MODE switch and the selection of the Band Select switches. The NAND gate A10U14B detects when the last programmed band has been swept and indicates that no more bands are available to be selected.

There are, therefore, four distinct events that may independently force a reset function: operator programmed, remotely programmed, the last plot of a page, and the sweeping of the last programmed band (farthest right Band Select switch).

5.3.3 Start Circuitry

Refer to Figure 5-5, Detailed Block Diagram Reset-Start-Sweep Circuitry, Figure 5-6, Functional Block Diagram Logic Start Circuitry, and Figure 5-7 Functional Block Diagram Logic control.

The start circuitry is located on Logic Control assembly A10, and on assemblies A14, and A15. It is operated by START switch, S29, which starts the clock and band count. The clock stops and a band sweep starts when an inhibiting signal is applied to the logic control circuit.

Activation of the START switch forces A15-8 to go low and then high, and A15-C to go high and then low. A15U5B and A15U5C, dual input NAND gates, form a switch-bounce filter that triggers one-shot multivibrator, A15U6. This start pulse is connected to pin A10-2 and sets flip-flop start latch A10U3B, so that A10U3B-6 goes low. This action allows only one start pulse to pass through gate A10U2A. A10U2D is used as a logical OR gate. A10U2D-11 will go high if either a remote start from the

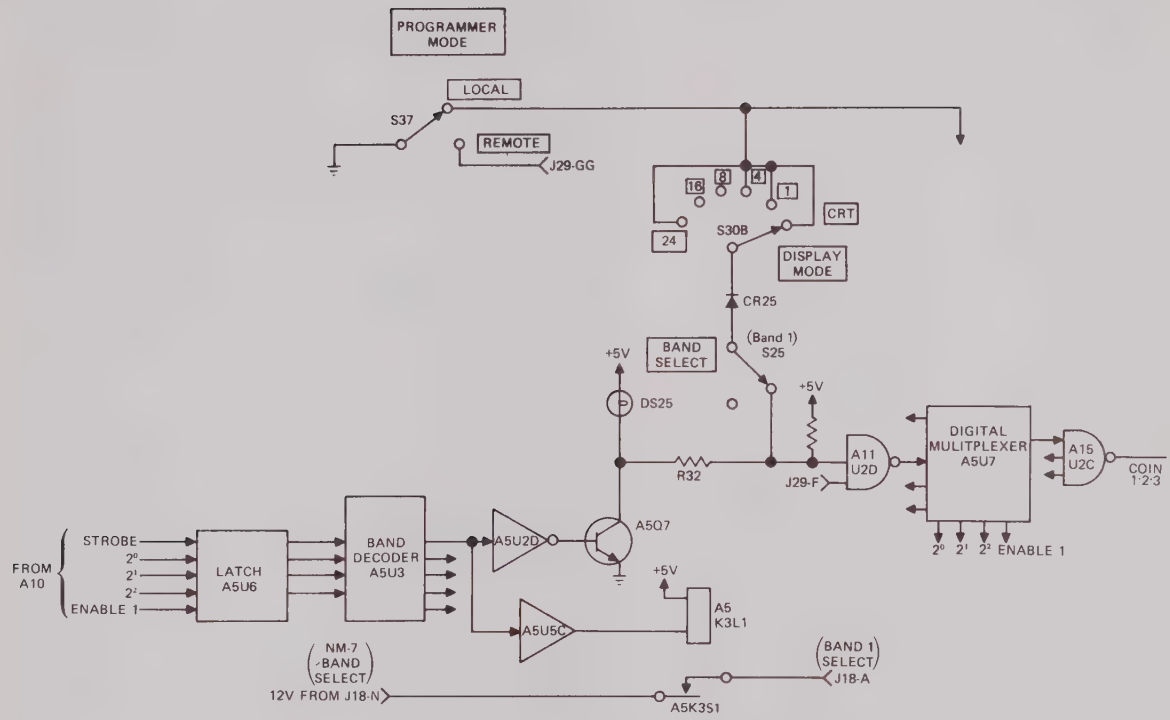


Figure 5-2. Functional Block Diagram, Band Select Circuitry

Figure 5-3. Detailed Block Diagram, Band Select Circuitry

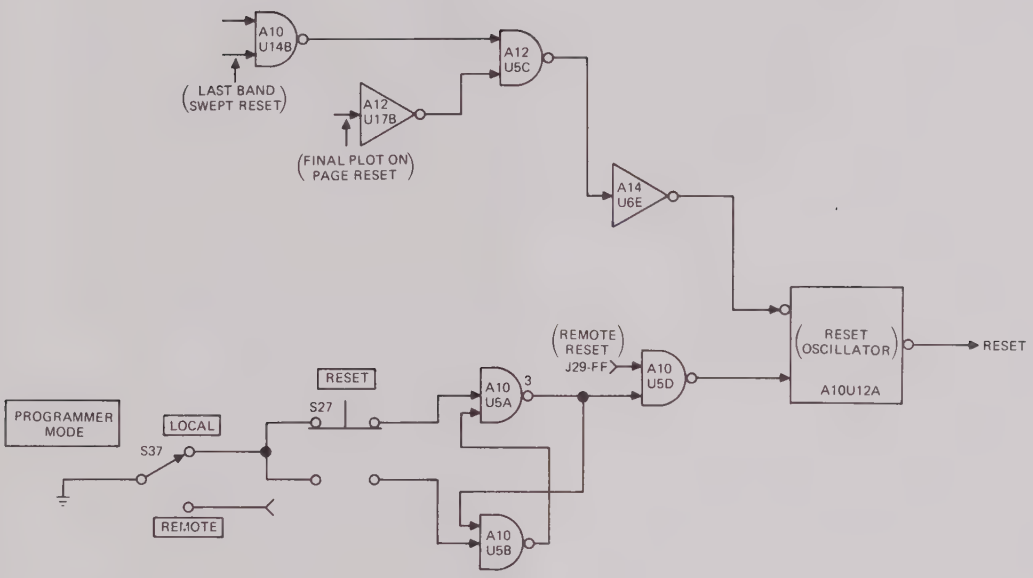


Figure 5-4. Functional Block Diagram, Reset Circuitry

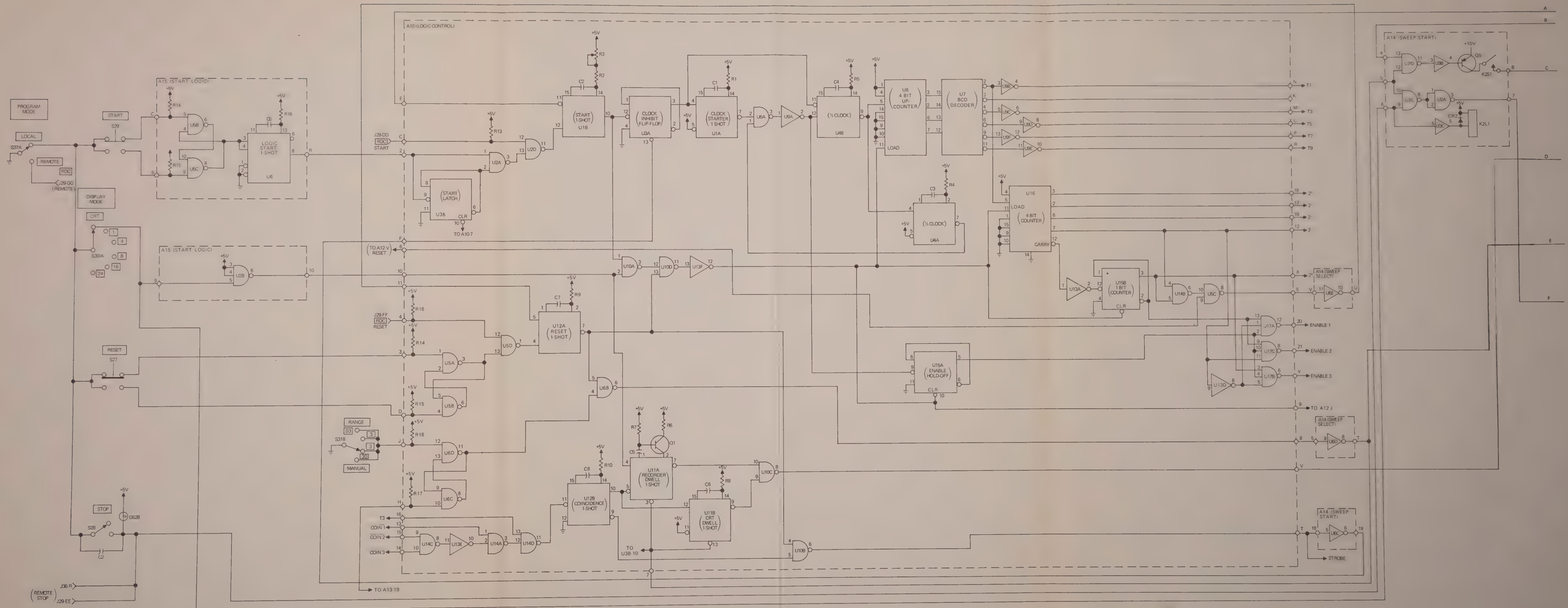


Figure 5-5. Detailed Block Diagram, Reset, Stop, Start, and Sweep Circuitry Sheet 1 of 2

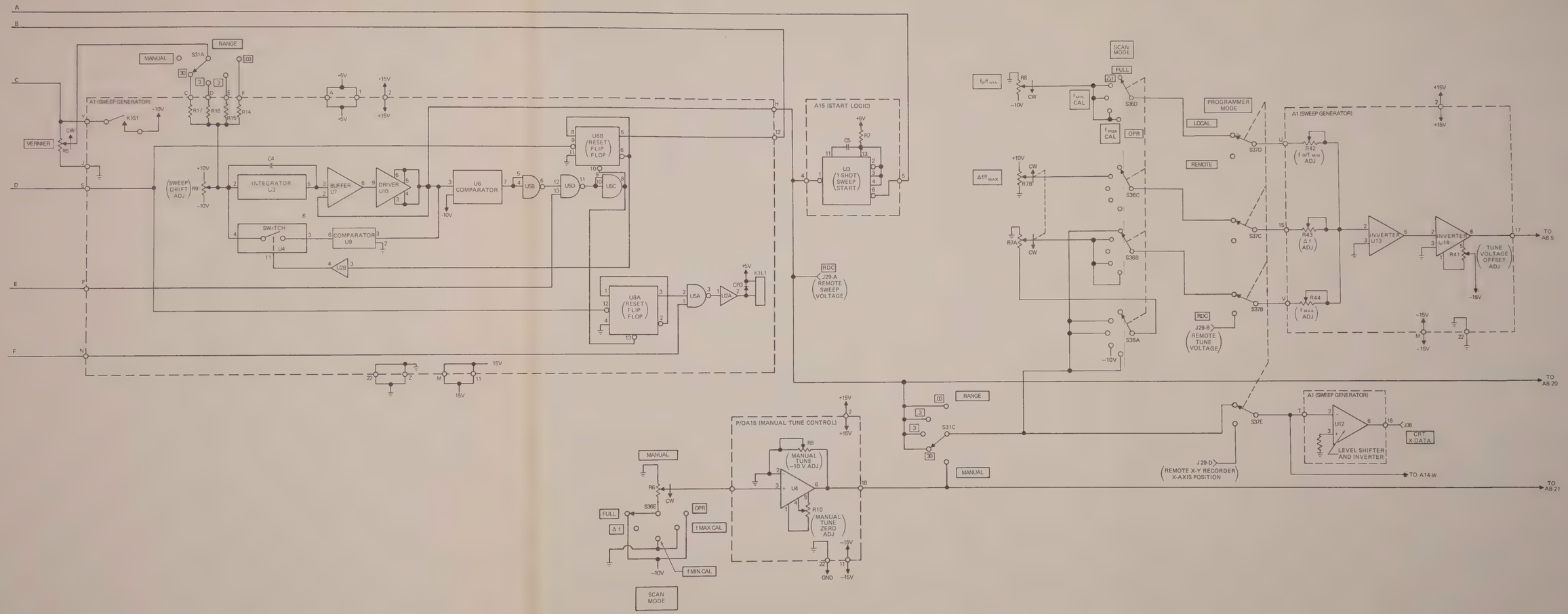


Figure 5-5. Detailed Block Diagram, Reset, Stop, Start, and Sweep Circuitry Sheet 2 of 2

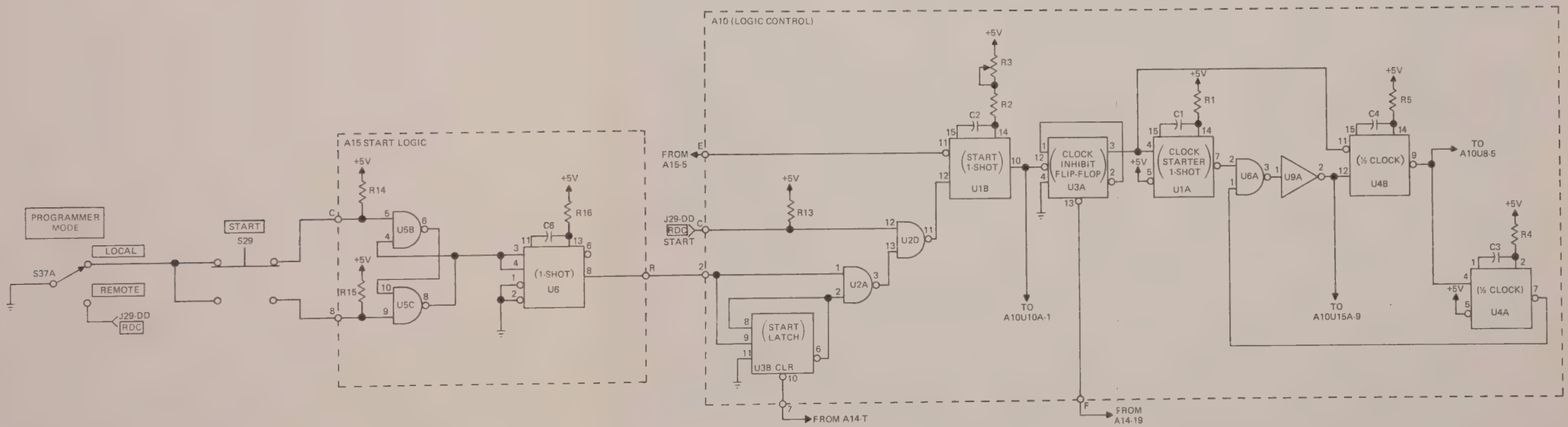


Figure 5-6. Functional Block Diagram, Logic Start Circuitry

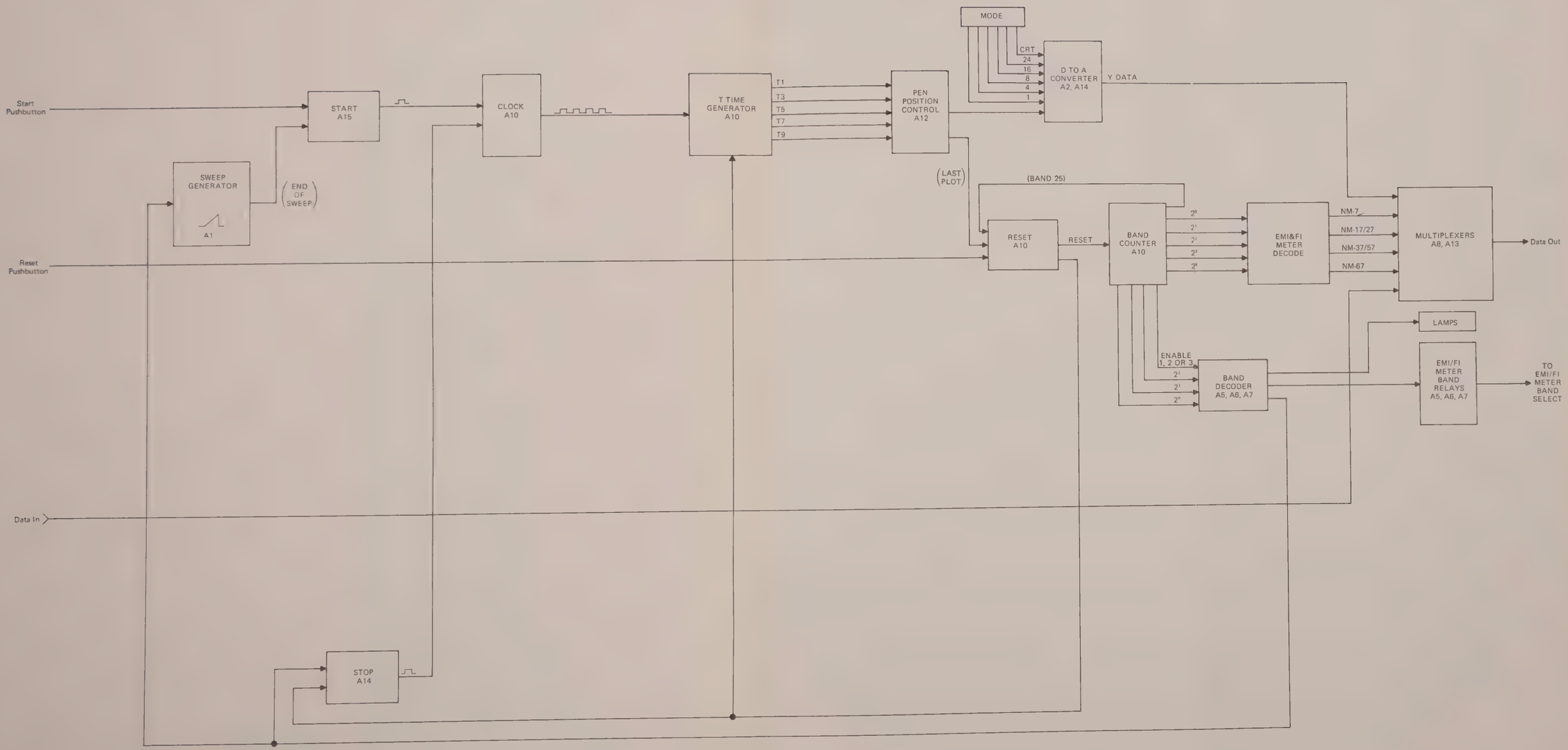


Figure 5-7. Functional Block Diagram, Logic Control Circuitry

Remote Digital Controller or a start pulse through A10U2A occurs. This action will trigger start one-shot multivibrator A10U1B.

The pulse from A10U1B will set Clock Inhibit flip-flop, A10U3A, so that A10U3A-3 goes high. This action triggers clock starter one-shot multivibrator, A10U1A, and enables one-shot multivibrator A10U4B. A10U1A, gate, A10U6A, and inverter, A10U9A, form a gating network that allows one-shot multivibrators A10U4A and A10U4B to form a square wave oscillator, which is utilized as a clock. The oscillator continues until A10-F goes low, resetting A10U3A which causes A10U4B-11 to go low, shutting off the clock oscillator. The inhibiting signal to A10-F is originated in the logic control circuit, A10, when a coincidence signal arrives from one of the three Band Decoder circuits, A5 thru A7, indicating that the band count coincided with a band which was programmed.

The 1 MHz clock signal from A10U4B is connected to a 4 bit counter, A10U8. While the clock is oscillating, A10U8 will count upwards. The 4 bit output of A10U8 is applied to 4 line to 10 line BCD to Decimal Decoder, A10U7, so that only one of six outputs of A10U7 will be low at a time. Sequential timing pluses T1 thru T9 are available at the pins A10-N, A10-K, A10-M, A10-U, A10-P and A10-R through Hex Inverter, A10U9. Since a reset reloads A10U8 with a code of 0010, the first pulse occurs at T2, which is not utilized. The first utilized timing pulse is T3, followed by T5, T7, T9 and T1. The pulse sequence timing diagram is displayed in Figure 5-8.

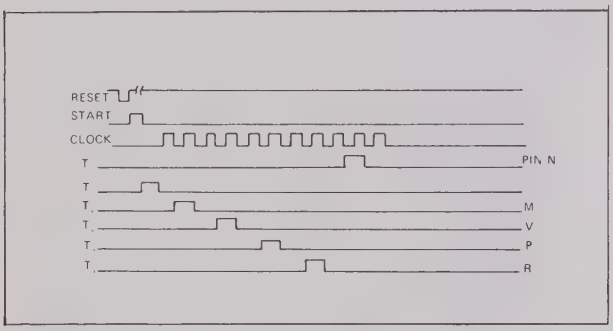


Figure 5-8. Timing Pulse Sequence Diagram

The timing pulses are connected to the Digital Pen Control circuit, A12.

The T1 pulse from A10U7-2 is also applied to 4 bit counter, A10U16. A10U16 and A10U15 form a 5 bit binary counter. Three binary lines, 2^0, 2^1, 2^2, are used for band selection in the Band Decoder and Multiplexer circuits, A5 thru A7. All 5 binary lines; 2^0, 2^1, 2^2, 2^3, 2^4 are used for the antenna switch and digital display control via the Digital Buffer circuit, A15.

The last two bits are connected to 3 input NAND gates, A10U17, to produce Enable signals 1, 2 and 3 at A10-21, A10-20 and A10-Y, one at a time, in sequence. The Enable signals are applied to the Band Decoder circuits, A5 thru A7. The timing diagram of the first 3 binary band select signals and of the 3 enable signals is displayed in Figure 5-9. When an enabled Band Selector circuit detects a programmed band (depressed Band Select switch), it sends a coincidence signal back to A10. (See Figure 5-3.)

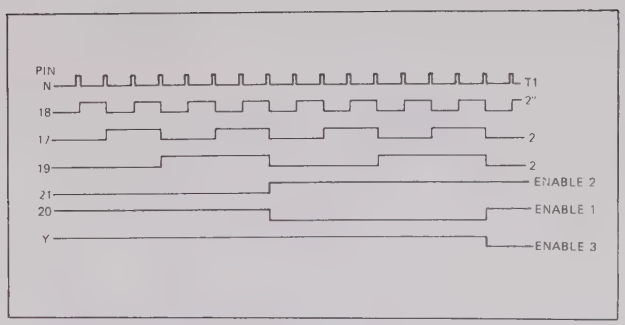


Figure 5-9. Binary Code. Enable Signals Timing Diagram

When any of the coincidence signals arrive to A10-13, A10-15 or A10-14, the output of NAND gate A10U14A-3 goes high. The next T3 timing pulse, connected to A10-16, will then be able to pass NAND gate A10U14D and trigger coincidence one-shot multivibrator A10U12B. When A10U12B is triggered, A10U10B acting as an OR gate sets A10-T high (Strobe). Inverter A14U6C sets the A10-F low, resets inhibit flip-flop, A10U3A, and stops the clock.

When coincidence one-shot multivibrator, A10U12B, is triggered, Recorder Dwell one-shot multivibrator A10U11A or CRT Dwell one-shot multivibrator A10U11B, is also triggered. After the proper dwell time, 3 seconds for Recorder and 1 millisecond for CRT display mode, A10U10C yields a positive pulse to A10-V that appears at the sweep generator circuit, A1-S, and initiates a sweep. The dwell time one-shot multivibrators are selected by the DISPLAY MODE switch, S30A, via A15U2B gate.

5.3.4 Sweep Circuitry

Refer to Figure 5-5 and Figure 5-10. The sweep generator circuit is located on assembly A1 and is controlled by the SWEEP TIME RANGE switch, S31, and the VERNIER control. Assembly A1 contains a +10 V and −10 V regulator A1U1, A1U11 (displayed on Figure 5-27), a zero to −10 V sweep generator A1U3, A1U7, A1U10, two sweep comparators A1U9 and A1U6 for zero and −10 V, a flip-flop, A1U8, and analog switch, A1U4, to terminate the sweep when −10 V is reached, tuning voltage limiters, A1U13 and A1U14, controlled by the SCAN MODE switch, S36, and a level shifter for the CRT X data, A1U12.

When a start pulse arrives from the Logic Control, A10, to A1-S, flip-flop A1U8 is set. Analog switch, A1U4, is then turned off via buffer A1U2B and integrator A1U3 is enabled to start a sweep. At the same time A1U8A turns on relay, A1K1 via gate, A1U5A, and buffer, A1U2A. When A1K1 is closed, +10 V is applied to the SWEEP TIME VERNIER control and returned through the SWEEP TIME RANGE switch to the integrator, A1U3, causing C4 to charge linearly toward −10 V. The integrator output is connected via buffer, A1U7, and driver, A1U10, to pin A1-H and also to comparator, A1U6. When the sweep output reaches −10 V, comparator, A1U6, changes state and resets flip-flop, A1U8, through gates, A1U5B, A1U5D, and A1U5C. When A1U8 is reset, A1U4 is closed and A1K1 is opened via gate, A1U5A, and buffer, A1U2A, allowing the sweep to reset. A15U3 connected to A1-H is also triggered, applying a starting pulse to A10U1B. This action restarts the clock and the sequence begins again. If the CRT Display Mode is used, this pulse will also reset all the logic through A10U10A. This allows the same band to be swept

repetitively. This sequence of events continues until the band counter on A10 is stopped by automatic reset of the clock as described in Paragraph 5.3.2.

If the CRT Display Mode is selected, the +10 V to the SWEEP TIME VERNIER control is applied from A14-B. A1K1 is opened and A14K2 is closed. The integrating current is applied by transistor, A14Q5, enabling rapid sweeping and retrace, which could not be achieved with a relay. The fast retrace is accomplished by Reset flip-flop, A1U8B, via A14U2D and A14U3B.

The tuning voltage limiter is an inverting adder, A1U13, controlled by the SCAN MODE switch and fo/fMAX, Δf/fMAX controls. In the SECTOR SCAN position the tuning voltage is limited from Vmin to Vmax; in the Δf Mode from

$$Vo - \frac{\Delta V}{2} \text{ to } Vo + \frac{\Delta V}{2}$$

The full or limited tuning voltage is inverted and buffered by A1U14 and appears at A1-17.

The level shifter, A1U12, inverts and shifts the 0 to −10 V sweep to provide a −5 V to +5 V output to drive the X axis of the oscilloscope display.

5.3.5 Stop Circuitry

Refer to Functional Block Diagram, Stop Circuitry, Figure 5-11, and Detailed Block Diagram Reset, Stop, Start, Sweep Circuitry, Figure 5-5.

The stop circuit is located on the Sweep Select assembly, A14, and on the Sweep Generator assembly, A1, and is associated with the STOP switch, S28, and DISPLAY MODE switch, S30. Stop is achieved when +10 V is removed from the SWEEP TIME VERNIER control. Since +10 V is applied to the VERNIER control in the RECORDER display mode by relay, A1K1, and in the CRT display mode by relay, A14K2, through transistor switch, A14Q5, two stop circuits are activated when the STOP switch is depressed. The STOP switch illuminates the stop lamp and sets NAND gates, A14U2D and A14U2C, high.

If the RECORDER display mode is used and the STOP switch is operated, the high output of NAND gate, A14U2C, sets inverter, A14U2A, low and NAND gate, A1U5A, cuts off relay, A1K1, via buffer A1U2A. A1K1S1 then removes +10 V from the VERNIER control. NAND gate, A1U5A, is also used for retrace in the RECORDER mode as described in Paragraph 5.3.4.

If CRT display mode is used and STOP is operated, the high output of NAND gate, A14U2D, cuts off transistor switch, A14Q5, via buffer A14U3B. In the CRT mode, however, relay A14K2 is on; opening transistor switch, A14Q5, removes +10 V form the VERNIER control and stops the sweep. NAND gate, A14U2D, is also used for retrace in CRT mode as described in Paragraph 5.3.4.

5.3.6 X-Y Recorder Circuitry

Refer to Functional Block Diagrams, Figures 5-12 and 5-13, and Detailed Block Diagram, X-Y Recorder Pen Control Circuitry, Figure 5-14.

The X-Y Recorder circuitry is responsible for positioning the pen properly before the sweep begins and for scaling the sweep voltage in the X and Y axes, to provide proper spacing between the plots.

The starting point for each plot in the multiplot modes is established by a six-bit digital code; four bits in the X axis, and 2 bits in the Y axis. (See Paragraph 5.3.7.) The coding is achieved in the Digital Pen Control circuit, A12, controlled by the DISPLAY MODE switch, S30. The pen position code is translated by the Digital-to-Analog Converter circuit, A2, into analog outputs, to position the X-Y recorder pen. The scaling of the X and Y data is established in the Sweep Select circuit, A14, controlled also by the DISPLAY MODE switch. The starting point data and the scaled X and Y data are added on the digital-to analog converter circuit assembly, A2, to obtain the X and Y outputs to be applied to the X-Y recorder.

a. Digital-to-Analog Converter Circuit

The digital-to-analog converter circuits located on assembly A2, are essentially identical for both the X and Y axes. The X axis digital-to-analog converter controls the horizontal motion; the Y axis digital-to-analog converter controls the vertical motion of the recorder pen.

By selecting the DISPLAY MODE switch position, it is possible to plot either 1, 4, 8, 16 or 24 plots on one page, which requires 1, 2, 4 or 6 plots from the left to the right in the X axis (see Paragraph 4.3.6, Plots-per-Page Format). The lowest common multiple of these numbers is 12, indicating that the digital-to-analog must be capable of moving the pen in increments of 1/12 of the entire page width, to select the starting point of all possible plots. Since 12 is represented by the binary number 1011, it is necessary to have a four-bit digital-to-analog converter in the X axis. The $X2^0$, $X2^1$, $X2^2$ and $X2^3$ bits from the Digital Pen Controller, A12, appear at A2-N, A2-15, A2-J and A2-9. They will move the pen in N/12 fractions of a page width, where N equals the number determined by the 4-bit binary word $X2^0$, $X2^1$, $X2^2$ and $X2^3$ (logical 1 means that ground is applied to the corresponding pin of A2).

Each of the X axis binary lines is capable of operating a relay, A2K5, A2K6, A2K3 and A2K4, that switches −10 V into one of the scaling resistors of A2Z2. The scaling resistor determines the proper voltage to be applied to the X output, to move the pen appropriately. Another scaling resistor in A2Z2 is responsible for scaling the sweep voltage to move the pen during sweep. If one plot-per-page is selected, the sweep voltage is applied from the Sweep Select circuit, A14, to A2-8. If 4 plots-per-page is selected, the sweep voltage is applied to A2-7. For 8 plots-per-page or 16 plots-per-page the sweep voltage is applied to A2-M, and for 24 plots-per-page the sweep voltage is applied to A2-T.

To plot 1, 4, 8, 16 or 24 plots on a page requires 1, 2 or 4 plots in the Y axis from top to bottom (see Plots-per-Page Format in Paragraph 4.3.6). The lowest common multipler of these numbers is 4, which is represented by the binary number 11. Therefore only a two-bit digital-to-analog converter is needed in the Y axis. The $Y2^0$ bit from the Digital Pen Controller, A12, is applied to A2-F and the $Y2^1$ bit is applied to A2-4. The binary lines operate relays, A2K1 and A2K2, and switch −10 V into the proper scaling resistor of A2Z1. The summing network A2Z1 also scales the Y axis data signal. For one plot-per-page the Y

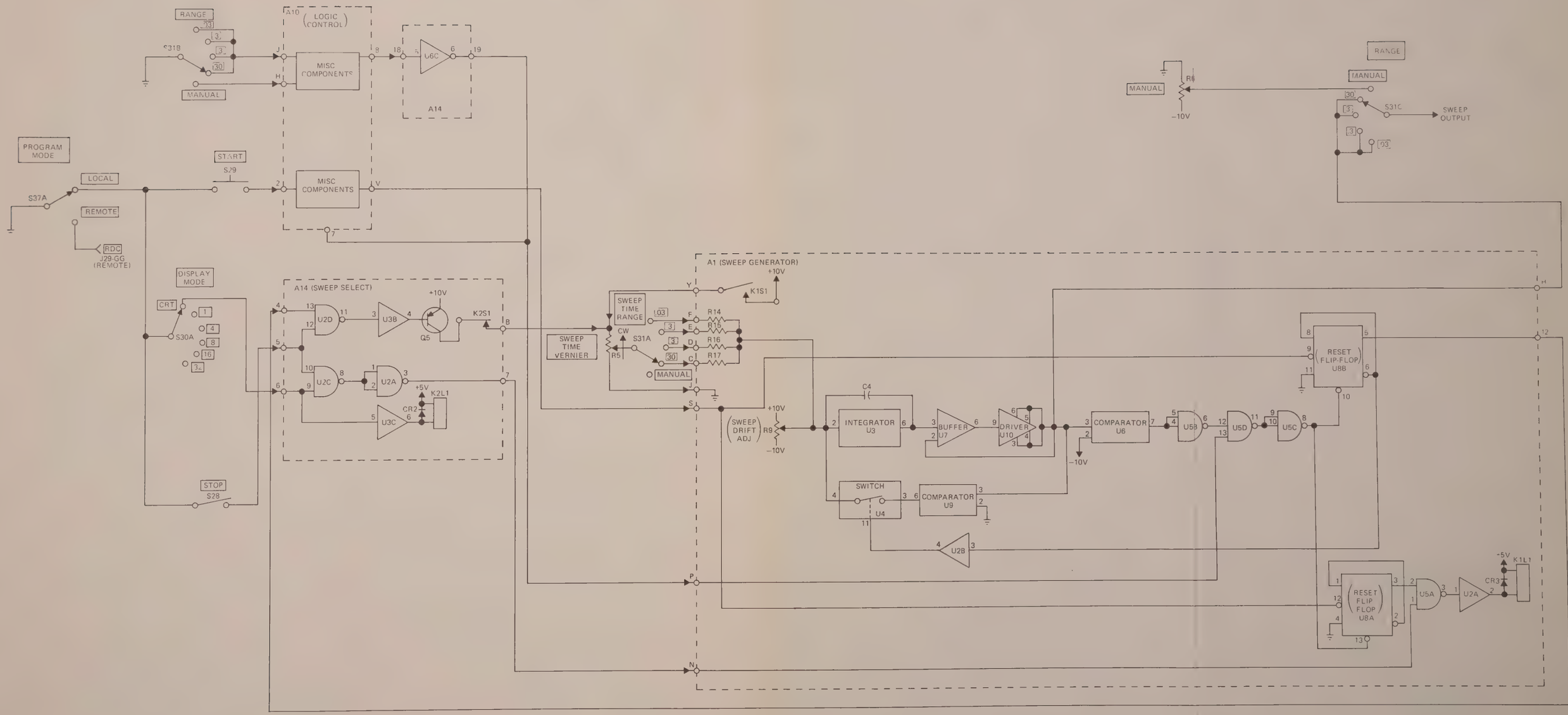


Figure 5-10. Functional Block Diagram, Sweep Generator Circuitry

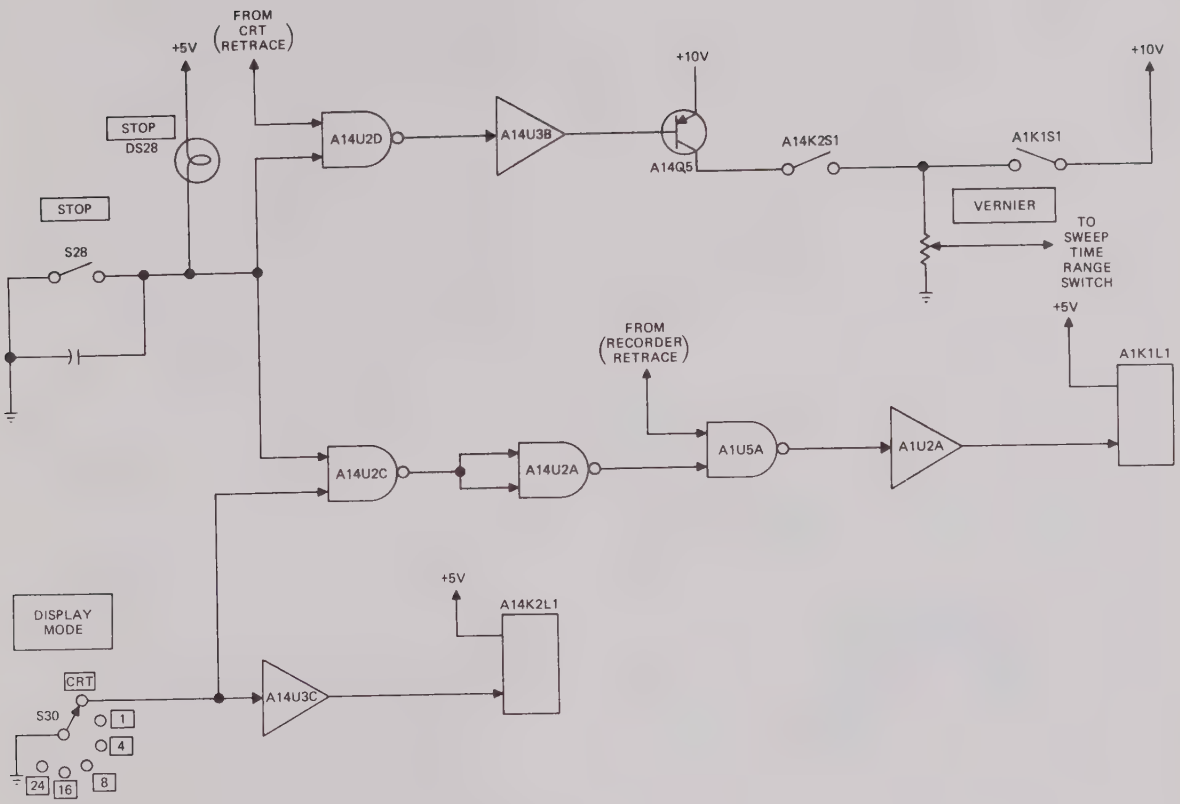


Figure 5-11. Functional Block Diagram, Stop Circuitry

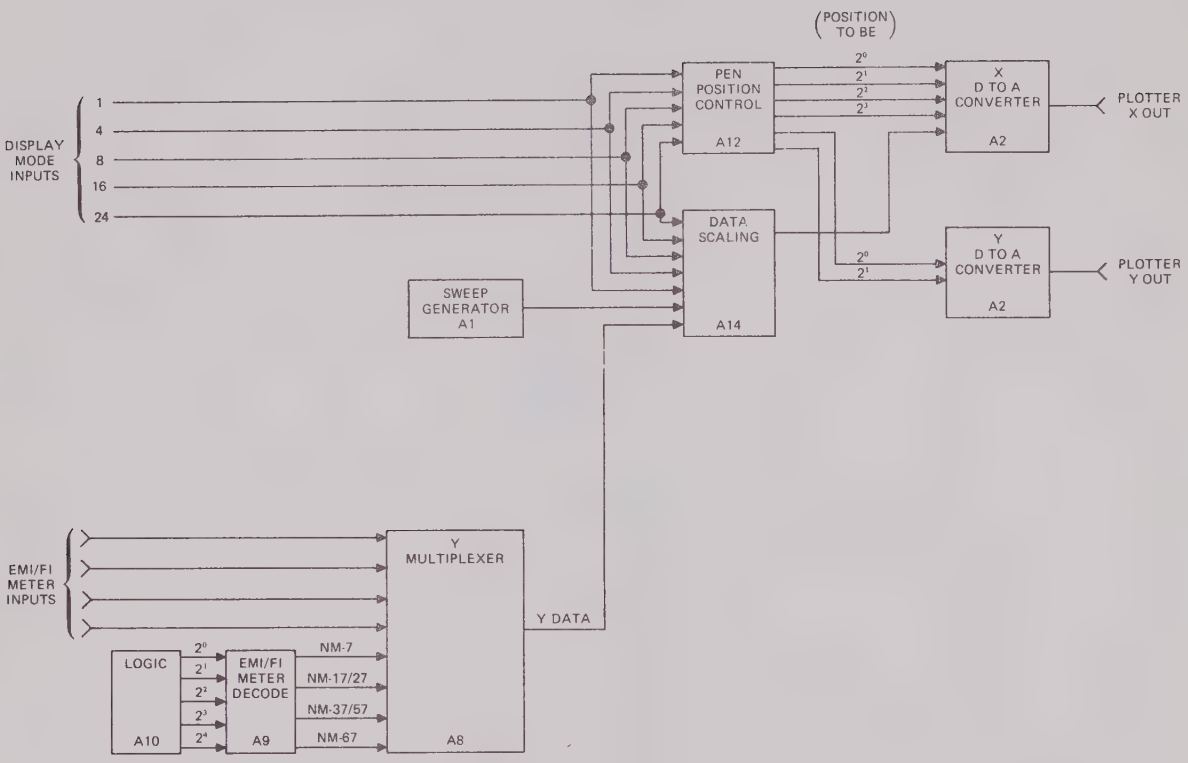


Figure 5-12. Functional Block Diagram, Digital-to-Analog Converter Circuitry

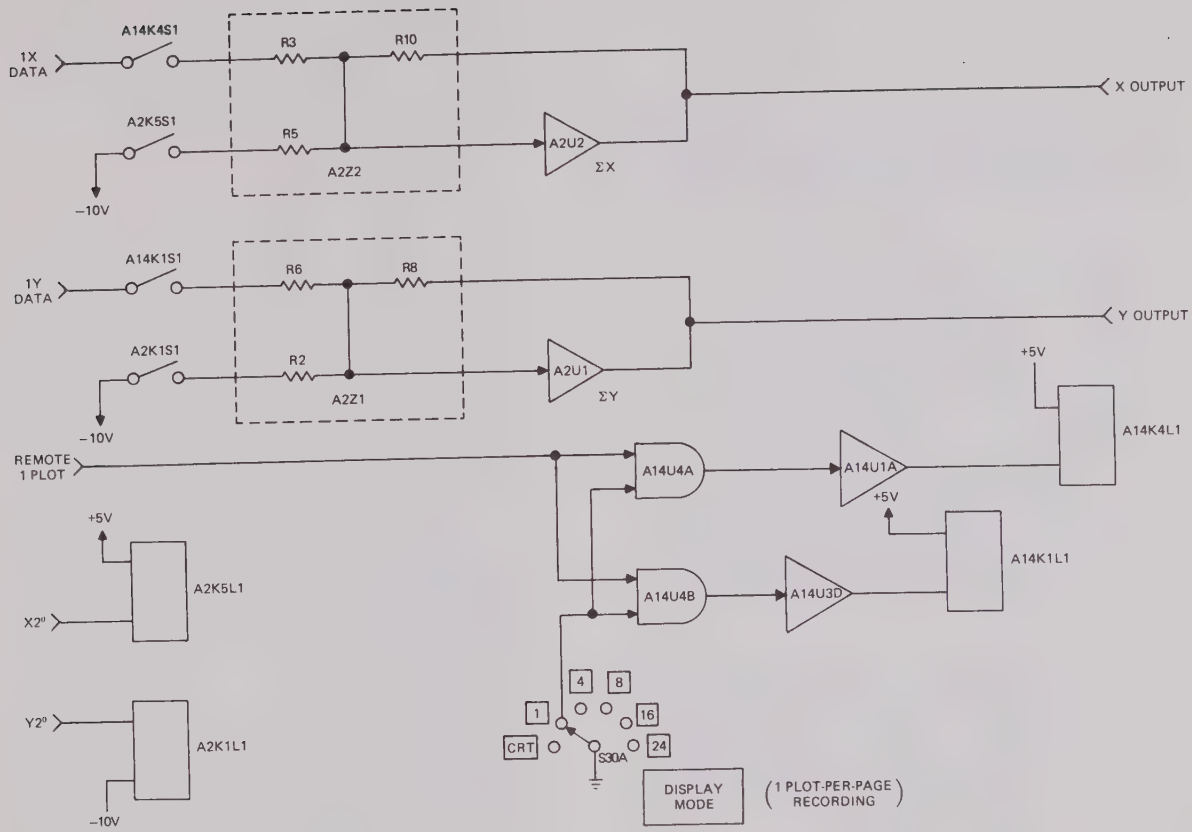


Figure 5-13. Functional Block Diagram, Sweep Select Circuitry

data is applied from the Sweep Select circuit, A14, to A2-C; for 4 or 8 plots-per-page. The Y data is applied to A2-D and for 16 or 24 plots-per-page to A2-E.

The X data adder is composed of operational amplifier, A2U2, and summing network, A2Z2. The X output appears on A2-R. The Y data adder contains operational amplifier, A2U1, and summing network, A2Z1. The Y output appears on A2-5.

b. Sweep Select Circuit

The sweep select circuit located on assembly, A14, selects the proper scaling resistors in the X axis and Y axis adder, to obtain the pen movement corresponding to the DISPLAY MODE switch position.

If one plot-per-page display mode is selected locally or remotely, the outputs of AND gates, A14U4A and A14U4B, used as negative OR gates, go low. The gates energize relays, A14K4 and A14K1, via drivers, A14U1A and A14U3D. A14K4 connects the X voltage (manually adjusted or swept) to A2-8 and A14K1 connects the multiplexed Y data to A2-C.

If 4 plot-per-page display mode is selected, A14U4D goes low and NAND gate A14U7A goes high. A14U4D energizes relay A14K3 via driver A14U1B; and A14U7A energizes A14K7 via inverter, A14U6F, and driver, A14U1F. A14K3 applies the X voltage to A2-7 and A14K7 applies the Y data to A2-D.

If 8 plots-per-page display mode is selected, four input NAND gates A14U5B and A14U7A go high. A14U5B energized relay A14K8 via inverter, A14U6A, and driver, A14U1D. A14U7A energizes relay A14K7 via inverter, A14U6F, and driver, A14U1F. A14K8 connects the X voltage to A2-M and A14K7 connects the Y data to A2-8.

If 16 plots-per-page display mode is selected, NAND gates, A14U5B and A14U5A, go high. A14U5B energizes relay A14K8 via inverter, A14U6A, and driver, A14U1D. A14U5A energized relay A14K6 via inverter, A14U6B, and driver. A14U1E. A14K8 applies the X voltage to A2-M, and A14K6 applies the Y data to A2-E.

If 24 plots-per-page display mode is selected. A14U4C, acting as negative OR gate, goes low and energizes relay, A14K5, via driver, A14U1C. NAND gate, A14U5A, goes high and energizes relay A14K6 via inverter, A14U6B, and driver A14U1E. A14K5 applies the X voltage to A2-T, and A14K6 applies the Y data to A2-E.

c. Slew Rate Limiting Circuits

There are two slew rate limiting circuits on assembly A2: one for the X axis, A2U3, A2U4, A2U5, A2U6; and one for the Y axis, A2U7, A2U8, A2U9, A2U10.

The circuit operates by allowing the integrators, A2U4 and A2U8, to integrate to the levels at the input, A2U6 and A2U10, at a rate that is controlled by analog switches, A2U5 and A2U9. The slew rate is limited to 2 volts per second when the switches are open and 2000 volts per second when the switches are closed. The switches are controlled by the signal at A2-19, derived from A13-U via A14U3F. This signal allows rapid slewing only when the pen is lowered on the page (so that no data is lost by slew limiting and so that ink droplets from the pen will not smear the paper when retrace occurs.

The output to the X-Y recorder is buffered by A2U3 and A2U7. The inputs are derived from the X-Y RECORDER switch, which places zero volts at A2-21 and A2-20 when in the ZERO CAL position and 2.0 volts when in the MAX CAL position, The 2.0 volts is derived from variable resistor, A15R3.

d. Pen Lift Control

The pen lift control circuit is on assemblies A13 and A14. The pen lift control is a relay, K1, located on the chassis driven by A14Q1 and A14Q2. When either A14-9 or A14-10 is low, A14Q1 and A14Q2 will saturate, which energizes the relay, K1, and drops the pen. A14-9 is an external control which may be applied by a Remote Digital Controller. A14-10 is derived from the gating circuitry on assembly A13. If the CRT position of the DISPLAY MODE switch is selected, A13-20 will go low. If the STOP switch is depressed, A13-W will go low. Either of these conditions forces A13U9C-8 to be low. If the MANUAL position of the SWEEP TIME RANGE switch is selected, A13-19 will be low. A13-15 will only be high when a sweep is occurring. A low at A13-15 or A13-19 forces A13U9B-6 to go low. If either A13U9B-6 or A13U9C-8 is low, A13U9D-11 will be low. A13-18 will be low if the PEN switch is in the UP position. If A13U9D-11 or A13-18 is low, A13U9A-3 will be low. A13-U will then be high, de-energizing the relay, K1, and lifting the pen. The pen relay driver signal at A13-U, will be low only if A13U9A-3 is high or A13-V (PEN switch at DOWN position) is low. Therefore the pen will only be down if A13-18, A13-15, A13-19, A13-20 and A13-W are high or A13-V is low.

5.3.7 Digital Pen Position Control Circuitry

Refer to Detailed Block Diagram, Figure 5-14, and Functional Block Diagram, Figure 5-15.

The digital pen control circuitry located on assembly A12 and controlled by DISPLAY MODE switch, S30, is responsible for generating a six-bit digital code for the digital-to-analog converter. This six-bit code establishes the beginning point for each plot in the multiplot modes. The coding is four bits for the X-axis and two bits for the Y-axis.

The coding for each plotting format is displayed in Figure 5-16 thru 5-20.

The X axis code represents the number of 1/12ths of the entire page width and the Y axis code represents the number of 1/4ths of the entire page height of the starting point of each plot. The coding circuit is located on assembly A12. It contains gating circuits to control two four-bit binary counters; A12U6 for the X axis and A12U18 for the Y axis coding. The circuit detects which plotting mode is being used and enables various clock T

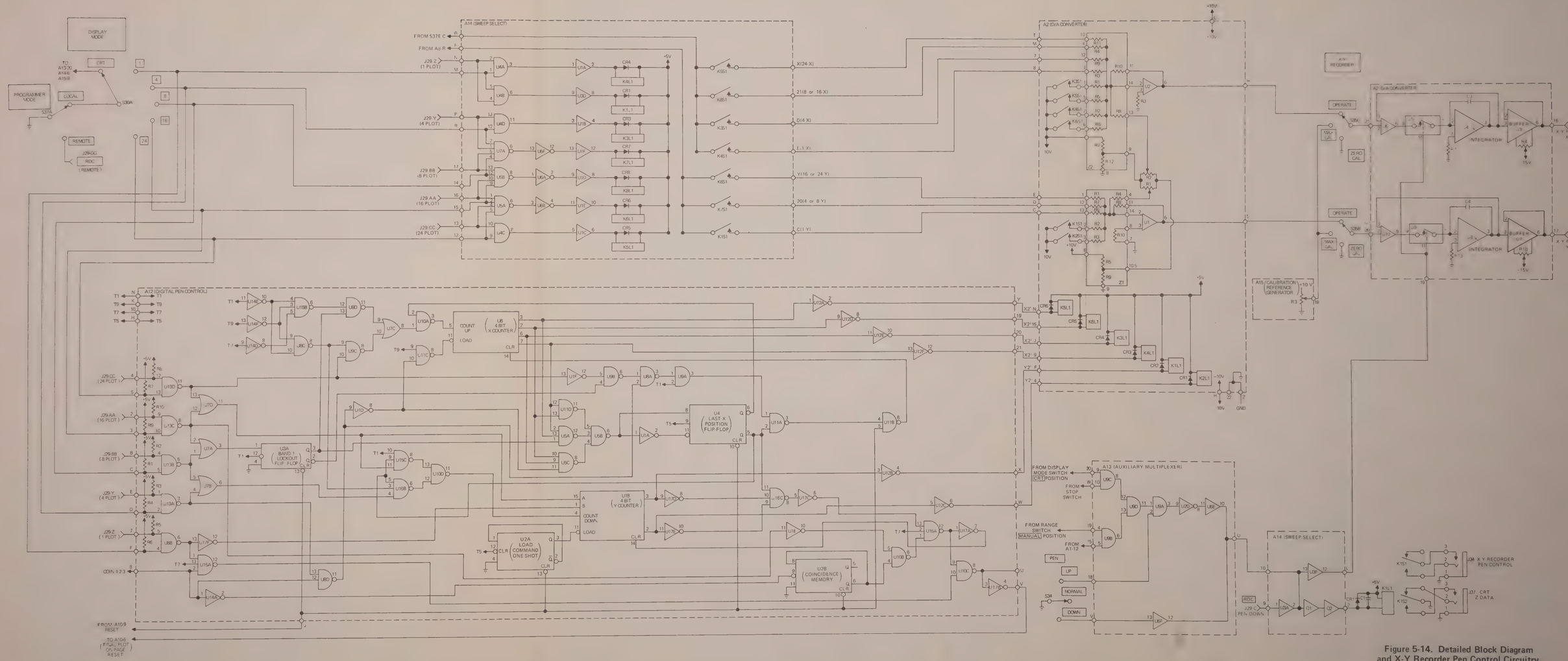


Figure 5-14. Detailed Block Diagram and X-Y Recorder Pen Control Circuitry

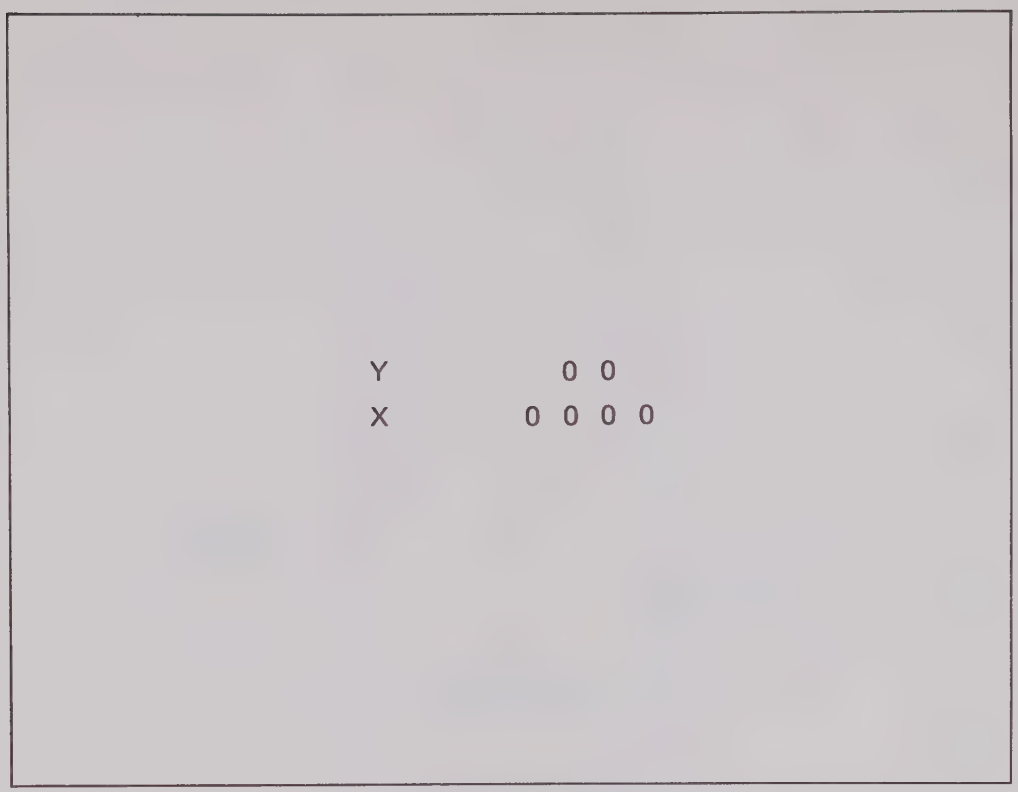


Figure 5-16. One Plot-per-page Coding

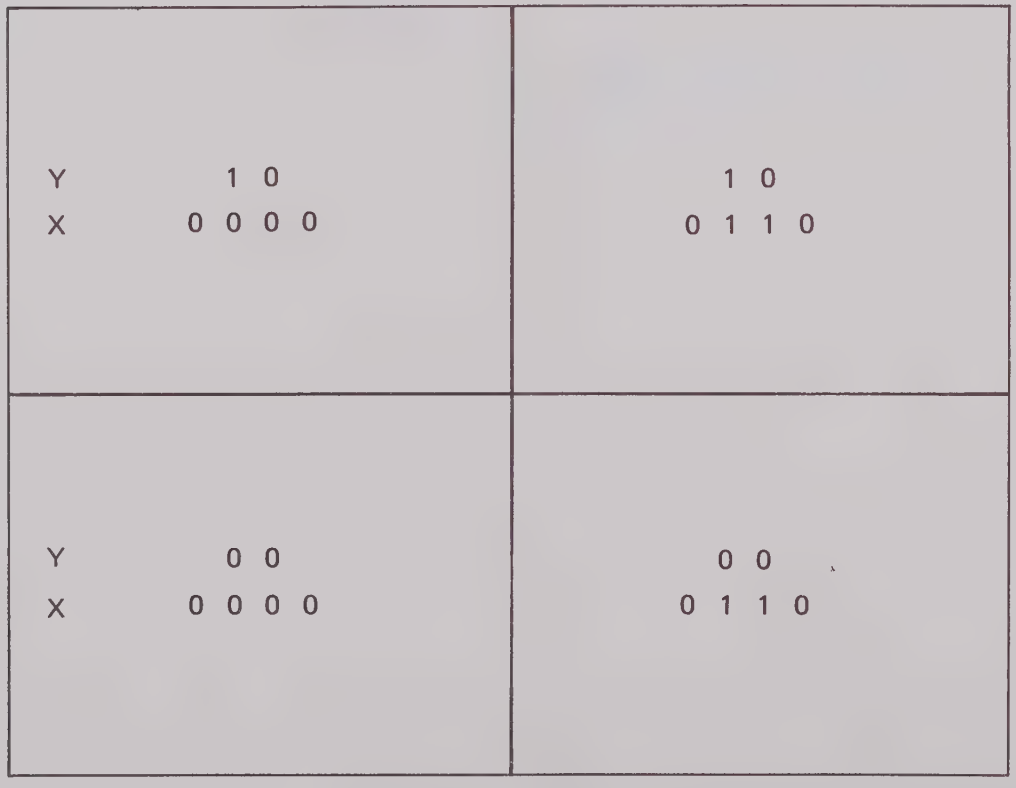


Figure 5-17. Four Plots-per-page Coding

Y 1 0 X 0 0 0 0	1 0 0 0 1 1	1 0 0 1 1 0	1 0 1 0 0 1
Y 0 0 X 0 0 0 0	0 0 0 0 1 1	0 0 0 1 1 0	0 0 1 0 0 1

Figure 5-18. Eight Plots-per-page Coding

Y 1 1 X 0 0 0 0	1 1 0 0 1 1	1 1 0 1 1 0	1 1 1 0 0 1
Y 1 0 X 0 0 0 0	1 0 0 0 1 1	1 0 0 1 1 0	1 0 1 0 0 1
Y 0 1 X 0 0 0 0	0 1 0 0 1 1	0 1 0 1 1 0	0 1 1 0 0 1
Y 0 0 X 0 0 0 0	0 0 0 0 1 1	0 0 0 1 1 0	0 0 1 0 0 1

Figure 5-19. Sixteen Plots-per-page Coding

Y 1 1 X 0 0 0 0	1 1 0 0 1 0	1 1 0 1 0 0	1 1 0 1 1 0	1 1 1 0 0 0	1 1 1 0 1 0
Y 1 0 X 0 0 0 0	1 0 0 0 1 0	1 0 0 1 0 0	1 0 0 1 1 0	1 0 1 0 0 0	1 0 1 0 1 0
Y 0 1 X 0 0 0 0	0 1 0 0 1 0	0 1 0 1 0 0	0 1 0 1 1 0	0 1 1 0 0 0	0 1 1 0 1 0
Y 0 0 X 0 0 0 0	0 0 0 0 1 0	0 0 0 1 0 0	0 0 0 1 1 0	0 0 1 0 0 0	0 0 1 0 1 0

Figure 5-20. Twenty-Four Plots-per-page Coding

times to count up the X counter and count down the Y counter. The last position flip-flop, A12U4, initiates the count down of the Y counter, when the last plot in the horizontal line is made. Coincidence Memory, A12U2B, detects the first programmed band when 8 plots-per-page display mode is used and enables the corresponding band decoder, A5 thru A7. Band 1 lockout flip-flop, A12U3A, prevents plotting Band 1, when 8 or 16 plots-per-page display mode is selected. Load Command one-shot multivibrator, A12U2A, loads the Y counter to the code corresponding the DISPLAY MODE switch position when all plots on a page have been completed and the programmer is reset. This sets the recorder pen in the proper position to start the next page.

The binary-coded pen positioning signals for the X axis are connected to the X axis digital-to-analog converter and those for the Y axis to the Y axis digital-to-analog converter on assembly A2. Since the two codes are different, the X and Y coding circuits will be described separately.

All display mode command inputs are multiplexed by OR gates; A12U8B (1 plot), A12U13A (4 plot), A12U13B (8 plot), A12U13C (16 plot) and A12U13D (24 plot), so that the display mode can be selected locally or by a remote digital controller.

a. X Axis Coding.

The X axis binary signals $X2^0$, $X2^1$, $X2^2$ and $X2^3$ are provided by the X counter, A12U6, and appear via inverters, A12U12A, A12U12D, A12U12E and A12U12F, at A12-Y, A12-19, A12-20 and A12-21. When the RESET switch is operated, all outputs of the X counter, A12U6-3, A12U6-2, A12U6-6 and A12U6-7, are low and the X axis code becomes 0000.

When 1 plot-per-page mode is commanded, the X counter, A12U6, remains unchanged, loaded with all zeros, and A12U8B-6 goes high. Whenever a programmed band is detected, a coincidence signal arrives at A12-8, and A12U15-2 goes high. The next T7 pulse from Logic Control, A10 drives A12U15A-13 high and A12U15A-12 low. A12U10C-8 goes high and A12U17B-4 goes low, causing an internal reset command at A12-V. Since the reset cycle occurs after the first programmed band is detected, there will be only one sweep produced before the unit resets.

When 4 plots-per-page mode is selected, A12U13A-3 goes high. When a coincidence signal arrives at A12-8, NAND gate, A12U8D, goes low and A12U1D-8 goes high. Then A12U11C will invert the next T9 pulse, loading X counter, A12U6, with a 0110 count (1/2 of a page). When the next coincidence signal arrives, A12U5C-11 will go high via A12U8D and A12U1D. Since A12U5C-9 and A12U5C-10 are high (count 0110) A12U5-8 goes low. A12U5B-6 then goes high and last X position flip-flop A12U4 will be loaded with the next T5 pulse. A12U4-5 goes high and resets the X counter, A12U6, via A12U11A, and A12U11B gates to 0000 (far left). The same sequence occurs for the next two plots, with the exception that with the Y counter A12U18 at 00. A12U17D-8 and A12U17E-10 are high and A12U16C-8 goes low, forcing A12U16A low at

the next T7 pulse. A12U10C-8 then goes low, yielding a reset signal to A12-V via A12U17B.

When 8 or 16 plots-per-page mode is selected OR gate, A12U7A, goes high and sets flip-flop, A12U3A, high with the next T1 pulse. This enables A12U9D to pass T1, T9 and T7. OR gate, A12U7C goes high and A12U10A forces X counter, A12U6, to count up 3 counts (1/4 page) each time the Logic Control, A10U16, counts up one increment. When X counter, A12U6, reaches a count of 1001 (3/4 page) A12U5A goes low, causing A12U5B to go high. The next T5 pulse sets last X position flip-flop, A12U4-5, high. The next T1 pulse is passed through A12U9A, A12U11A and A12U11B, resetting X counter, A12U6, to 0000. When last X position flip-flop, A12U4-5, is high, Y counter, A12U18, is allowed to count down to the next row. If, however, Y counter, A12U18, was in a 00 state (A12U18-2 and A12U18-3 low) A12U16C-8 will be low, and A12U17C-6 will be high. A12U10B-6 will be high if either A12U1E-10 is low (indicating 16 plots-per-page mode) or coincidence memory A12U2B-6 is low (indicating that at least one plot has been made in the 8 plots-per-page mode). On the next T7 pulse, A12U16 will then go low, and force A12U10C-8 to go high and create a reset.

When the 24 plots-per-page mode is selected, A12U13D-11 will be high. A12U9C will then pass all T9 and T1 pulses. OR gate, A12U7C, goes high and A12U10A forces X counter A12U6 to count up 2 counts (1/6 page) each time the Logic Control, A10U16, counts up one increment. When X counter, A12U6, reaches a count of 1010 (5/6 page), A12U11D-11 goes low, forcing A12U5B-6 high. The next T5 pulse sets last X position flip-flop, A12U4, and the next T1 pulse sets A12U9A high. These forces A12U11A low, A12U11B high and resets X counter, A12U6 to 0000. If Y counter, A12U18-2 and A12U18-3, are both low, indicating the last row and at least one plot has been made (Coincidence Memory A12U2B-6 is low), then A12U10B-6 will be high. With the next T7 pulse applied to A12U16-2, A12U16-12 will go low, resetting the logic through A12U10C and A12U17B.

b. Y Axis Coding.

The Y axis counter, A12U18, is a programmable down-counter. The A input A12U18-15 is high whenever A12U7D-11 is high, indicating a 16 or 24 plots-per-page mode. The B input A12U18-1 is high whenever A12U17F-12 is high, indicating that a mode other than 1 plot-per-page has been selected. When both inputs are high, the outputs at A12U18-3 and A12U18-2 will be 11 (3/4 of a page) as required for the 16 and 24 plots-per-page modes. If input A is high and input B is low, the outputs will be 10 (1/2 page) as required for the 4 and 8 plots-per-page modes. If both inputs are low, the output will be 00 as required for the 1 plot-per-page mode.

The Y counter, A12U18, counts down when pulses are applied to A12U18-4. A12U10D gates the pulses into A12U18-4 when they appear at A12U15C-8 or A12U16B-6. A12U15C and A12U16B will allow pulses to pass through only when the last X position flip-flop, A12U4-5, is high (last plot in any row). A12U15C-11 allows pulses only when A12U7D-11 is high (16 or 24 plots-per-page mode) and passes only T1, so that A12U18 counts down in increments of 1 (1/4 page). A12U16B-4 allows pulses only when A12U7B-6 is high (4 or 8 plots-per-page mode) and passes pulses T1 and T9 through A12U8C connected to A12U16B-3, so that A12U18 counts down in increments of 2 (1/2 page).

When a reset signal arrives from Logic Control, A10, to A12-J, all flip-flops will be reset and X counter, A12U6, cleared via A12U11B to 0000. When Load Command one-shot multivibrator, A12U2A, is reset, Y counter, A12U18, receives a load command and reloads according to the selected display mode. This sets the X-Y recorder pen to the proper position for the first plot on the page.

5.3.8 Data Signal Multiplexing Circuitry

Refer to Detailed Block Diagram, Figure 5-21.

Various frequency and signal level data are furnished to the Model P-7 Programmer from the four EMI/FI Meters. The Programmer decides which EMI/FI Meter is to be swept and choses the corresponding channel of data. The data multiplexers are located on the Analog Multiplexer assembly, A8, and on the Auxiliary Multiplexer assembly, A13. The multiplexers are controlled by the Receiver Decode circuit located on assembly, A9.

a. Receiver Decode

The Logic Control circuit, A10, generates a 5-bit word, that represents the binary count of the band, that is to be swept. This 5-bit word (2^4, 2^3 2^2, 2^1, and 2^0) is applied to pins A9-8, A9-R, A9-C, A9-2 and A9-B respectively. The decoder selects one of the four EMI/FI Meters according to the decoding scheme on Table 5-1. Logical 0 represents 0 V, logical 1 represents +5 V. The decoding is achieved by four bistable latches, U7A, U7B, U7C and U7D. The output of the latches are connected to A9-20, A9-21, A9-P and A9-M respectively.

When the input code is 00000, all inputs (A9-8, A9-R, A9-C, A9-2 and A9-B) are low. The three inputs to A9U4C are high and A9U4C-8 is low, A9U2D-8 is high. The inputs to A9U4B are high and A9U4B-6 is low. A9U5F-12 connected to the D input of latch, A9U7A, is high. Under these conditions each strobe from A10 connected to the Clock input of A9U7A will force A9-20 to go high, selecting the Model NM-7.

When the input code is 00xxx (x represents either high, or low), but A9-B, A9-2 and A9-C are not all low, then A9U4C-8 is high, A9U2D-8 is low and A9U4B-6 is high. A9U6B-4 is low, therefore A9U6B-6 is high and A9U2E-10 is low, forcing A9U1B-6 high. A9U6A-1 is also low, therefore A9U6A-3 is high and A9U2F-12 is low, forcing A9U1A-3 high. Since A9U1C-9 and A9U1C-10 are high, A9U1C-8 is low and A9U5E-10 is high. Furthermore A9U1D-12 is low, forcing A9U1D-11 high. Since all three inputs of A9U4A are high, A9U4A-12 is low and A9U5A-2 connected to the

Table 5-1. EMI/FI Meter Decoding Scheme

Inputs					Outputs (A9)				EMI/FI Meter	Band
4	3	2	1	0					Model	
2	2	2	2	2	Pin	Pin	Pin	Pin	Selected	
Pin					M	P	21	20		
8	R	C	2	B						
0	0	0	0	0	0	0	0	1	NM-7	1
0	0	0	0	1	0	0	1	0	NM-17/27	2
0	0	0	1	0	0	0	1	0		3
0	0	0	1	0	0	0	1	0		4
0	0	1	0	0	0	0	1	0		5
0	0	1	0	1	0	0	1	0		6
0	0	1	1	0	0	0	1	0		7
0	0	1	1	1	0	0	1	0		8
0	1	0	0	0	0	0	1	0		9
0	1	0	0	1	0	1	0	0	NM-37/57	10
0	1	0	1	0	0	1	0	0		11
0	1	0	1	1	0	1	0	0		12
0	1	1	0	0	0	1	0	0		13
0	1	1	0	1	0	1	0	0		14
0	1	1	1	0	0	1	0	0		15
0	1	1	1	1	0	1	0	0		16
1	0	0	0	0	0	1	0	0		17
1	0	0	0	1	1	0	0	0	NM-67	18
1	0	0	1	0	1	0	0	0		19
1	0	0	1	1	1	0	0	0		20
1	0	1	0	0	1	0	0	0		21
1	0	1	0	1	1	0	0	0		22
1	0	1	1	0	1	0	0	0		23
1	0	1	1	1	1	0	0	0		24
1	1	0	0	0	0	0	0	0	Automatic Reset	(25)

D input of latch, A9U7B, is high. Under these conditions each strobe will set A9-21 high, selecting the Model NM-17/27.

When the input code is 01000, the three inputs to A9U4C are high, therefore A9U4C-8 is low, forcing A9U1A-3 high. Because A9-R is high, A9U5B-4 is low forcing A9U4B-6 high. Because A9-8 is low, A9U6B-6 is high and A9U2E-10 is low, forcing A9U1B-6 high. Both inputs of A9U1C are high, therefore A9U1C-8 is low and A9U5E-10 is high. Furthermore A9U1D-12 is low, forcing A9U1D-11 high. Since all three inputs of A9U4A are high, A9U4A-12 is low, and A9U5A-2 is high as before, selecting with each strobe the Model NM-17/27.

When the input code is 01xxx and any of inputs A9-B, A9-2 A9-C is high, one of the inputs to A9U4C is low, forcing A9U4C-8 high. Because A9-8 is low and A9-R is high, both inputs to A9U6A are high, A9U6A-3 is low and A9U2F-12 is high. Both inputs to A9U1A are high, therefore A9U1A-3 is low, forcing A9U1C-8 connected to D input of latch A9U7C. In these conditions each strobe will set A9-P high, selecting the Model NM-37/57.

When the input code is 10000, all inputs to A9U4C are high, so A9U4C-8 is low and A9U2D-8 is high. Because A9-8 is high and A9-R is low, both inputs to A9U6B are high, A9U6B-6 is low and A9U2E-10 is high. Since both inputs to A9U1B are high, A9U1B-6 is low, forcing A9U1C-8 high as before, selecting the Model NM-37/57.

When the input code is 10xxx and any of inputs A9-B, A9-2 or A9-C is high, one of the inputs to A9U4C is low, forcing A9U4C-8 high. Because A9-8 is high and A9U4C is also high, both inputs to A9U1D are high and A9U1D-11 is low. A9U5C-6 connected to the D input of latch A9U7D, is high. In these conditions each strobe will be set A9-M high, selecting the Model NM-67.

b. Multiplexing Circuits

Analog Multiplexer circuit assembly, A8, contains the Log Video signal, the dB readout, the Y data and the Simultaneous FI data multiplexers. All data signals are switched by the decoded control lines connected to A8-7, A8-H, A8-F, and A8-6, via inverters, A8U8D, A8U8A, A8U8E, and A8U8F, respectively. The coincidence signal at A8-8 enables the multiplexers.

The Log Video signals connected to A8-18, A8-17, A8-V and A8-U are multiplexed by A8U11. A second multiplexer, A8U12, is used to select either the log video signal or the calibration signals in conjunction with the X-Y RECORDER switch, S35A. The multiplexed Log Video signal appears at A8-19 as CRT Y data. Comparator, A8U4, compares the sweep voltage with the manually-adjusted tuning voltage. When the sweep voltage exceeds the manual tuning voltage, the comparator changes state and triggers Manual Marker 1-shot multivbrator. A8U7. The 1-Shot multivibrator pulse is connected to the CRT data line to produce a marker blip on the CRT.

The dB Readout connected to A8-10, A8-9, A8-N, and A8-M are multiplexed by A8U9 and the multiplexed dB Readout data appears at A8-P.

The Y data connected to A8-L, A8-K, A8-S, and A8-T are multiplexed by A8U6. The multiplexed Y data for an X-Y recorder is level shifted and inverted in A8U3 and A8U2 and is connected to A8-R.

The Simultaneous FI data connected to A8-12, A8-13, A8-15, and A8-16 are multiplexed by A8U10. The multiplexed Simultaneous FI output appears at A8-14.

The tuning voltage connected to A8-5 is inverted by A8U1 and is multiplexed by relays, A8K4, A8K1, A8K3, and A8K2. The relays are operated by drivers A8U5F, A8U5C, A8U5E and A8U5D, which are controlled by the inverted decode signals.

Auxiliary Multiplexer circuit assembly, A13, contains the Frequency Readout and Auxiliary Input Multiplexers. Both are controlled by the decode lines connected to A13-6, A13-2, A13-5 and A13-4, through inverters, A8U2C, A8U2F, A9U2B, and A8U2A respectively.

The Frequency Readout data are connected to A13-F, A13-7, A13-D, and A13-C and are multiplexed by A13U4. A coincidence signal at A13-3 enables multiplexer A13U4 and the multiplexed Frequency Readout signal appears at A13-8.

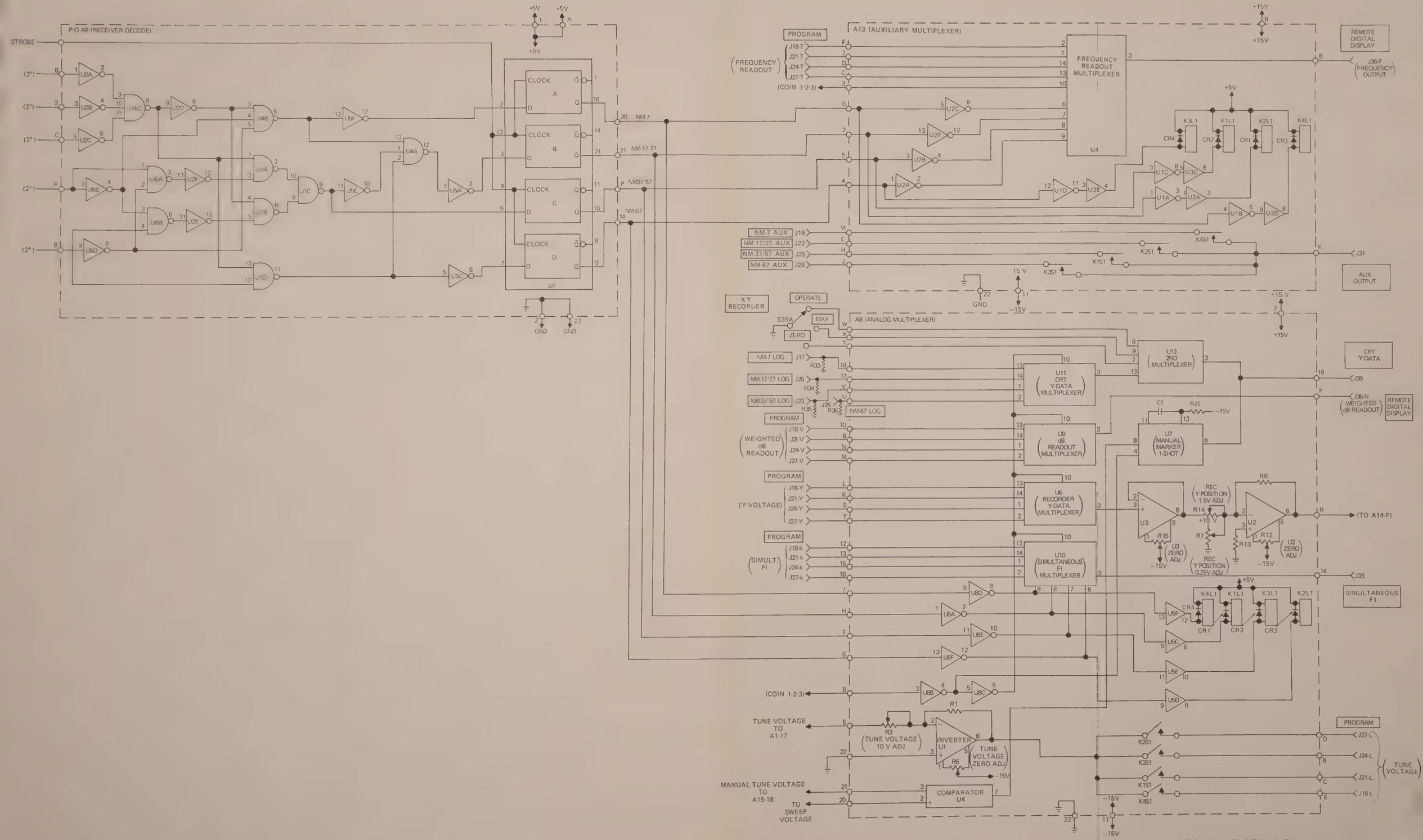


Figure 5-21. Detailed Block Diagram, Analog Signal Multiplexing

Auxiliary Input data are connected to A13-M, A13-L, A13-H, and A13-J. The decode lines are inverted by A13U1B, A13U1A, A13U1C, and A13U1D and multiplexed by relays A13K4, A13K2, A13K1, and A13K3 via drivers A13U3D, A13U3A, A13U3C, and A13U3B. The relays allow higher signal levels to be multiplexed up to 100 V or 1 amp, but must not exceed 10 watts.

5.3.9 Remote Attenuator Selection Circuitry

Refer to Block Diagram, Figure 5-22.

The attenuator circuitry is located on assemblies A13 and A16, and is controlled by REMOTE ATTEN switch, S38. The output of these circuits provides logic signals on any of six lines in conjunction with the REMOTE ATTEN switch position. Assembly A13 operates the 0 dB, 20 dB, 40 dB and 60 dB attenuators; assembly A16 operates the 80 dB and 100 dB attenuators in the Model IU-7A.

The attenuators are operated by logic signals, passing AND gates and buffers. The gates perform OR functions between the control panel and a Remote Digital Controller.

5.3.10 Bandwidth Selection Circuitry

Refer to Block Diagram, Figure 5-23.

The bandwidth selection circuits are located on Relay Driver assembly, A3. A relay closure provides +12 V to return from each EMI/FI Meter to one of four bandwidth lines. The relays are operated by the BANDWIDTH switch, S33, through AND gates and drivers. The gates perform OR functions between the control panel and a Remote Digital Controller.

5.3.11 Detector Function Selection Circuitry

Refer to Block Diagram, Figure 5-24.

The detector function selector circuits are located on Relay Driver assemblies A4 and A9. A relay closure is provided to return +12 V from each EMI/FI Meter to one of six detector function lines. Assembly, A4, contains the relays and associated logic circuits for the CAL, FI, QP and PEAK 0.05 functions; assembly, A9, contains those for the PEAK 0.3 and PEAK 3.0 detector functions.

The relays are operated by the DETECTOR FUNCTION switch, S32, through AND gates and drivers. The gates perform OR functions between the control panel and a Remote Digital Controller.

5.3.12 Digital Buffer Circuitry for Remote Digital Display Unit, Model DDU-7, and Remote Antenna Switch Model IU-7A

Refer to Block Diagram, Figure 5-25.

The digital buffer circuits are located on assembly A15. They invert and buffer the five binary-coded signals 2^0, 2^1, 2^2, 2^3 and 2^4, generated in the Logic Control circuit, A10, to provide inverted logic to drive the Model DDU-7 and Model IU-7A instruments.

5.3.13 Calibration Control Circuitry

Refer to Block Diagram, Figure 5-26.

The calibration voltage sources are located on assembly, A15. +10 V is generated by Zener diode, CR1, and Buffer, Q1; −10 V is generated by Zener diode, CR2, and buffer, Q2. +10 V is utilized to perform calibration control in the EMI/FI Meters Models NM-37/57 and NM-67. −10 V is utilized to calibrate the EMI/FI Meters Models NM-7 and NM-17/27. The four screwdriver-adjusted calibration controls are located on the front panel.

5.3.14 Digital Interface Circuitry

The digital interface circuitry is responsible for accepting logic commands and programming signals from the Control Panel and the Remote Digital Controller. The signals that are controllable either remotely or from the control panel are: the twenty-four band select signals, the bandwidth signals, the detector function signals, the remote attenuator signals, the display mode signals, the pen control signals, the start signal and the reset signal. Local or Remote control can be selected by the PROGRAMMER MODE switch, S37.

Each of these signals is in the negative logic mode. That is, the signal voltage will be low (0 to 0.8 volts) for a true command. Each of the commands is wired into an OR function between a Remote Digital Controller and the Control Panel. Each of the switches on the control panel has a common ground return that is disabled by the PROGRAMMER MODE switch, making it impossible to have any of these signals go to ground when operating in the remote mode.

The location of the gates performing this OR function is a function of the particular signal. The following list locates these gates. Table 5-1 defines the band number with the proper band of the EMI/FI Meters.

a. Band select signals:

   Bands 1-4, 9-12, and 17-20 inclusive, Assembly A11 (U1, U2, U3)

   Bands 5-8 inclusive, Assembly A5 (U8)

   Bands 13 to 16 inclusive, Assembly A6 (U8)

   Bands 21 to 24 inclusive, Assembly A7 (U8)

   For each of these gates, the output goes high (+2.0 to +5.0 volts) for any low input.

b. The bandwidth signals are located on Assembly A3 (U4). In this case, the gate output goes low if either input goes low.

c. Detector functions signals:

   CAL, FI, QP and DP (.05 sec.) are on Assembly A4(U4). DP (.3 sec) and DP (3 sec) are on Assembly A9(U6). These gate outputs also go low for any low input.

d. The remote attenuator signals are located on Assembly A13(U7) and A16(U7). These gate outputs also are low for any low input.

e. The display mode gates occur twice; once for the pen position control and once for the gating of the sweep to determine plot size. The pen control gates are on Assembly A12(U13) where any low input creates a high output. The sweep-scaling gates are on Assembly A14(U4, U5) where a combination of lows and highs are derived from low level inputs.

f. The pen control signals are located on Assembly A14 at the junction of R4 and U3-2. U3 is an open collector device that is used in a "wired OR" configuration.

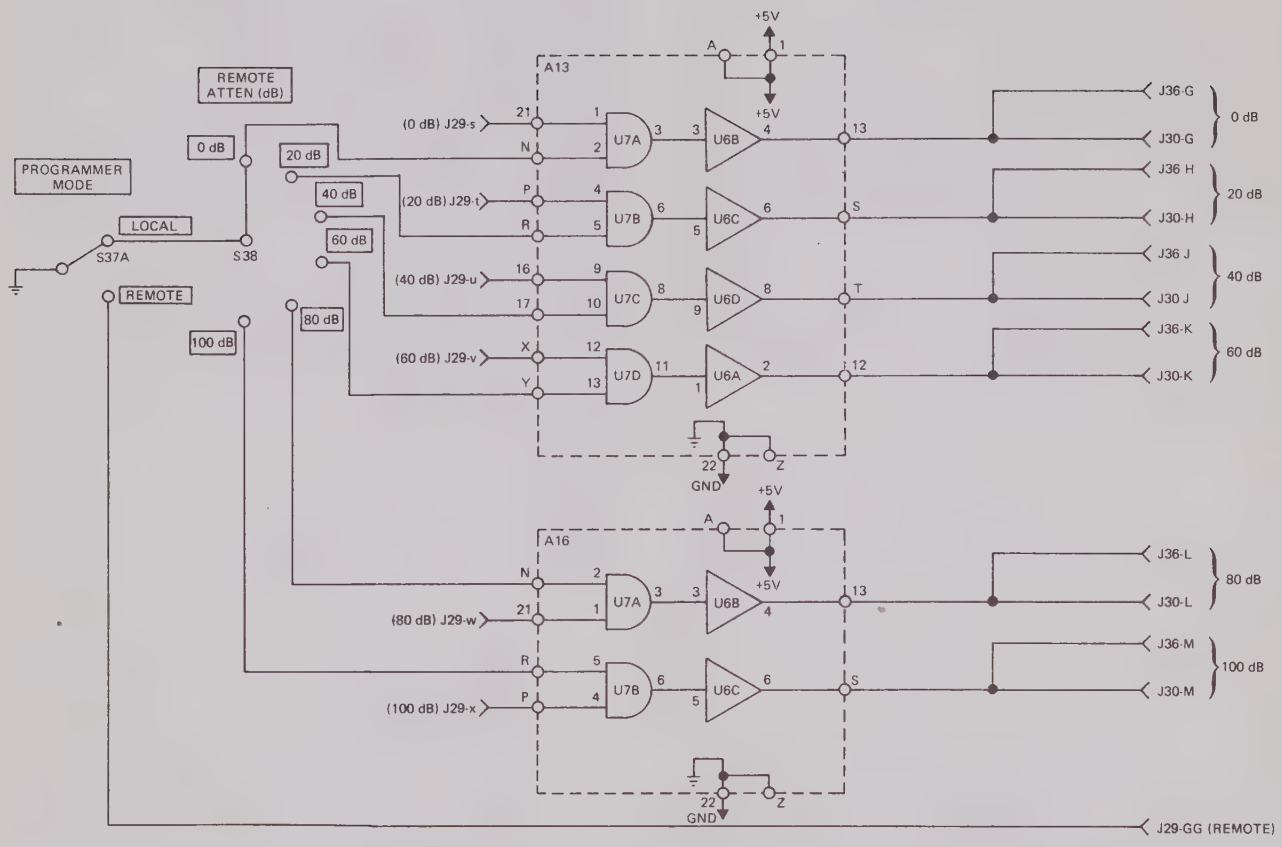


Figure 5-22. Detailed Block Diagram, Remote Attenuator Switch Circuitry

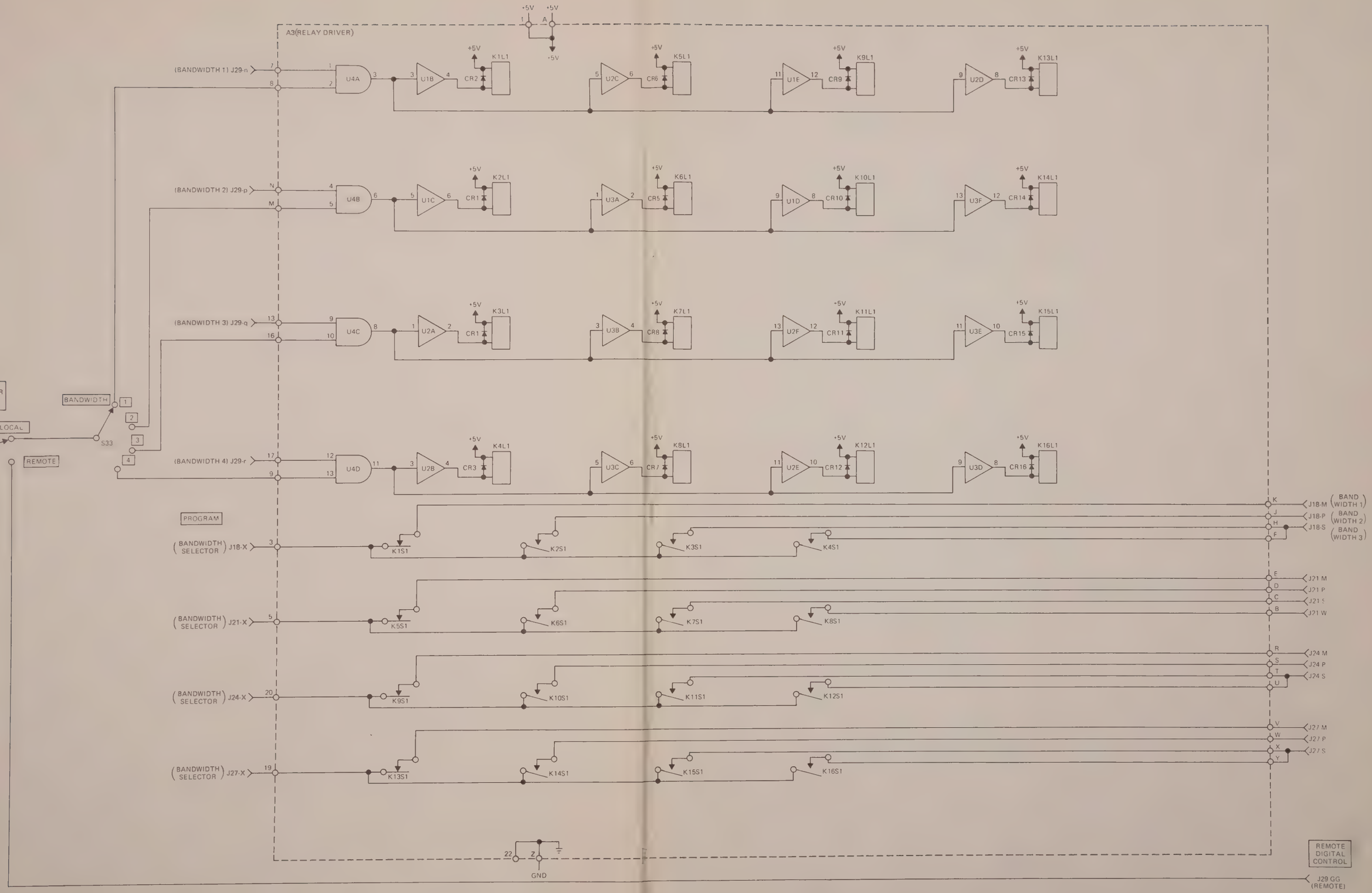


Figure 5-23. Detailed Block Diagram, Bandwidth Switch Circuitry

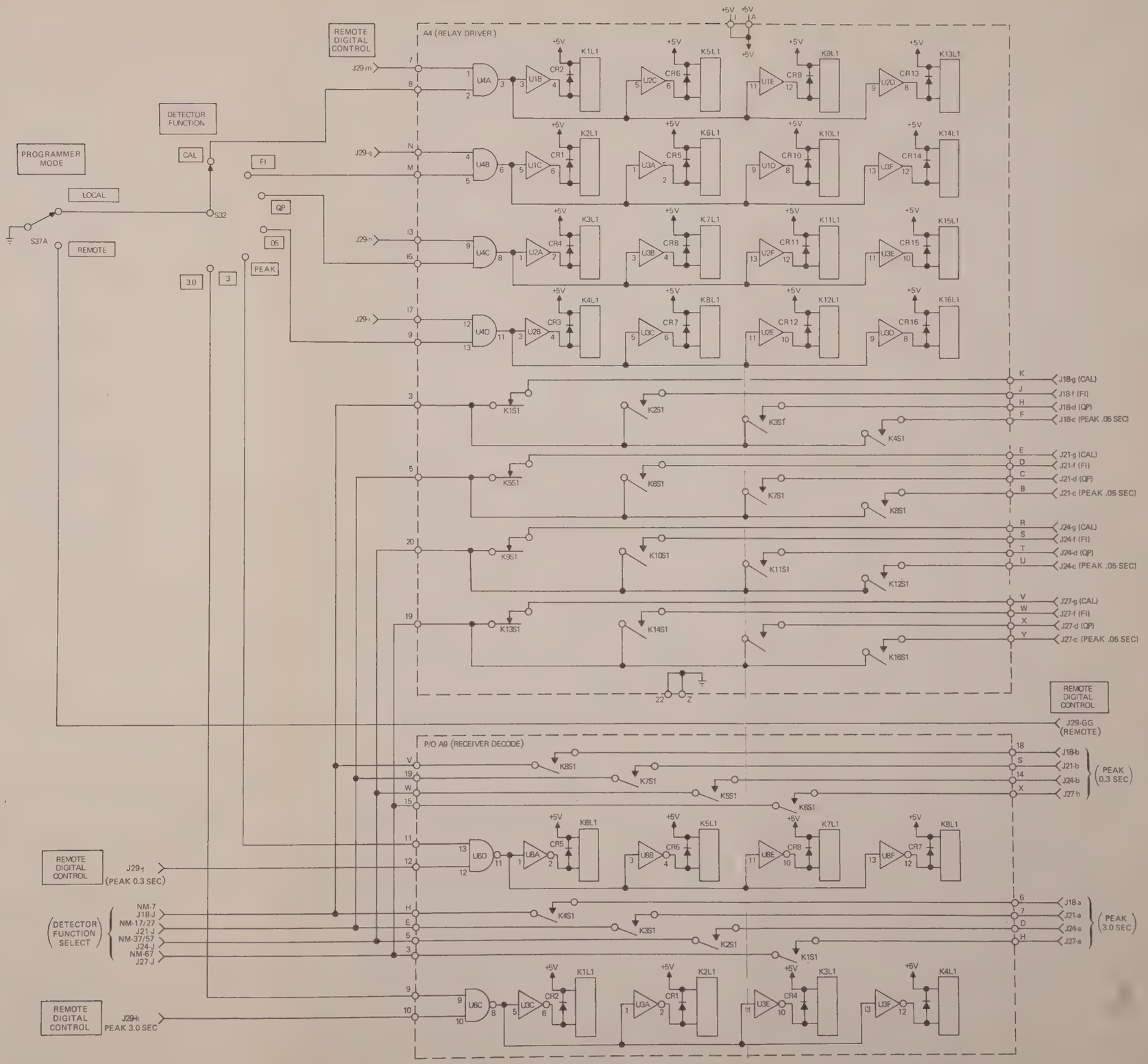


Figure 5-24. Detailed Block Diagram, Detector Function Switch Circuitry 5-41/5-42

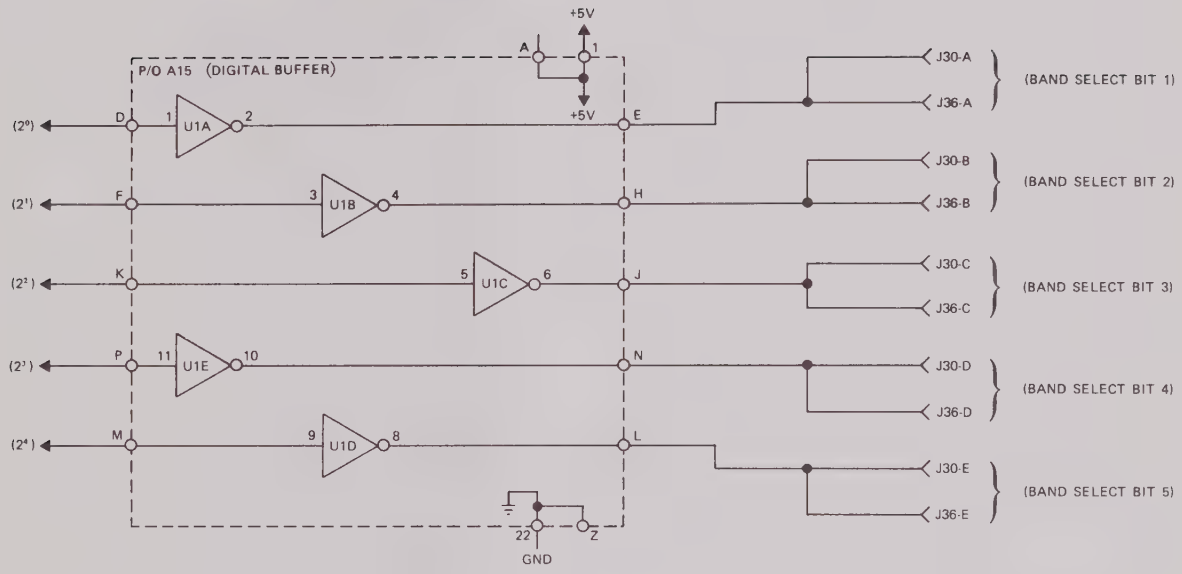


Figure 5-25. Detailed Block Diagram, Digital Buffer Circuit for Model DD U-7 and 1 U-7A

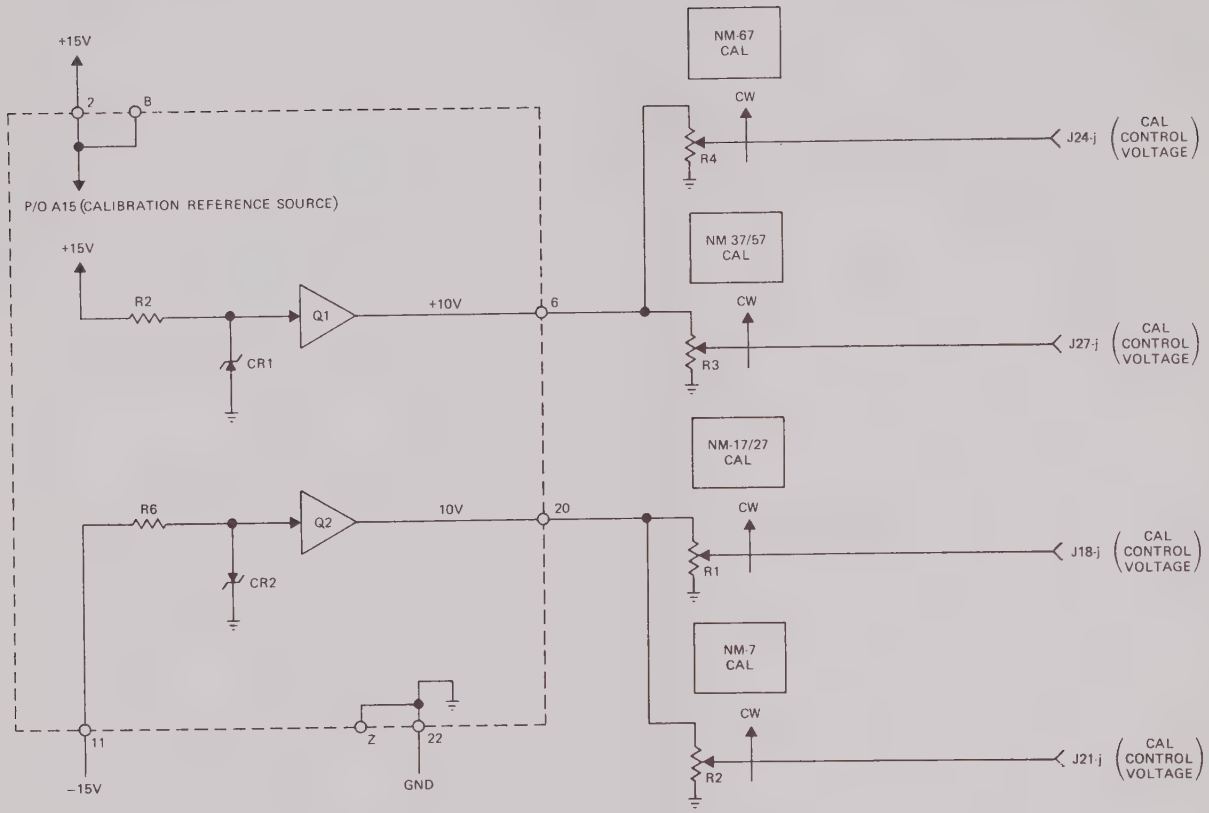


Figure 5-26. Detailed Block Diagram
Calibration Control Circuitry

g. The start and reset signals are located on Assembly A10(U2, U5).

The gates go high for any low input.

5.3.15 Power Supply Circuitry

Refer to Block Diagram, Figure 5-27.

Power supplies PS1-A1 thru PS1-A4 and power transformer T1 are located near the rear of the instrument. PS1-A1 provides +5 V for the logic circuits, PS1-A2 provides +5 V for the pushbutton lamps. +15 V is derived from PS1-A3 and −15 V from PS1-A4. Precisely regulated ±10 V are generated on the Sweep Generator assembly, A1, by voltage regulator, A1U1, and inverter, A1U11.

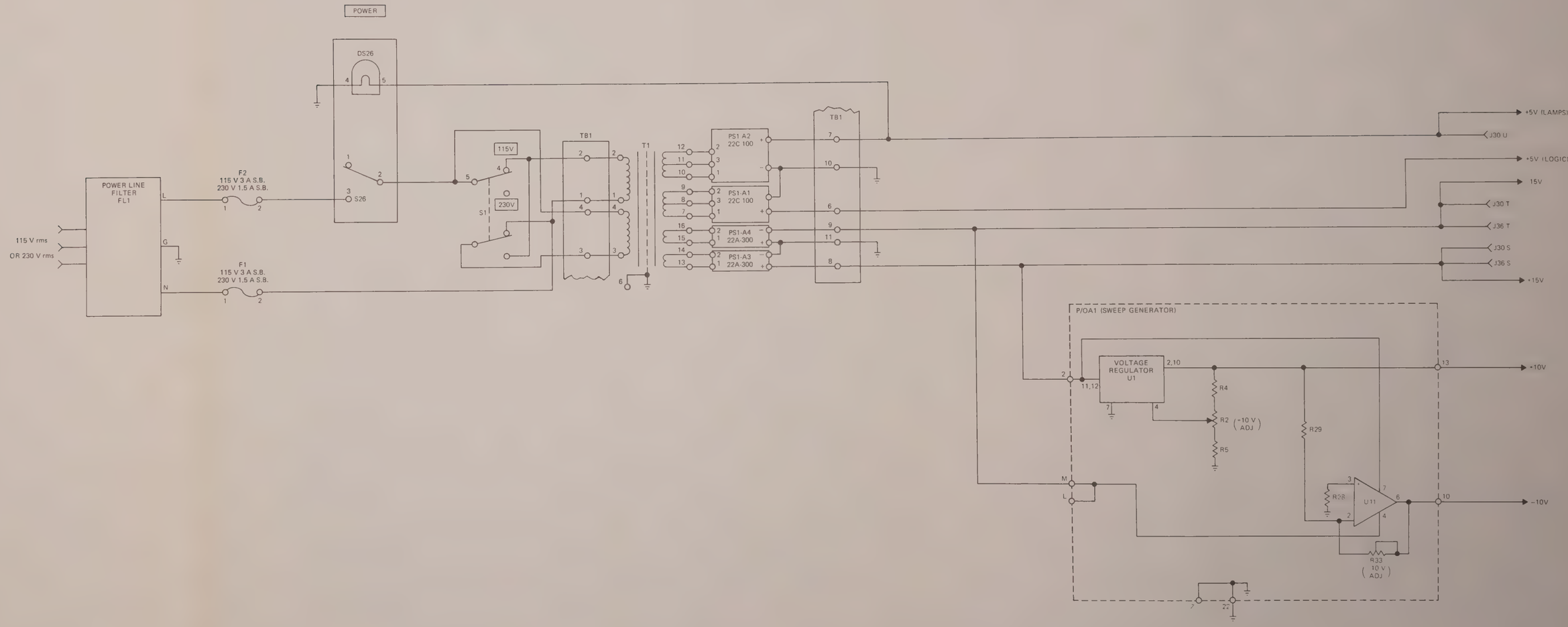


Figure 5-27. Detailed Block Diagram, Power Supply Circuitry

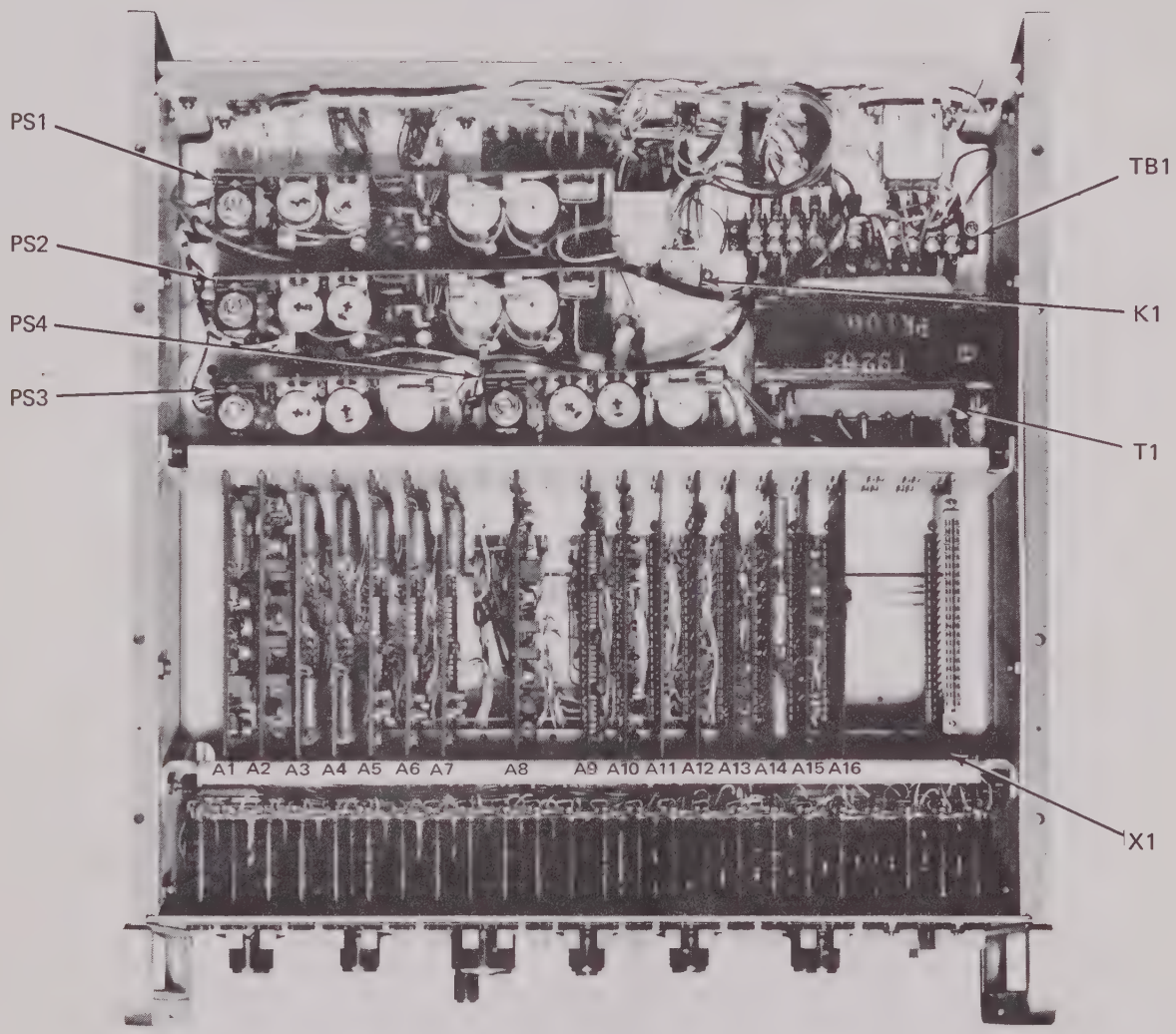


Figure 6-1. Location of Main Assemblies in Model P-7 Programmer

Section VI
MAINTENANCE

6.1 INTRODUCTION

This section of the manual contains minimum performance test procedures, disassembly procedures and alignment procedures for the Model P-7. The minimum performance test procedures are intended for verification that the Model P-7 is functioning in accordance with the specification requirements listed in Section II. Disassembly procedures are presented as necessary for ordinary maintenance requirements.

The maintenance and alignment procedures presented in this section of the manual are intended for use only by skilled personnel, well qualified and experienced in the calibration of laboratory test equipment. Alignment of the Model P-7 should not be attempted unless the instructions given in this manual are clearly understood and realignment is definitely required. The procedures for each functional section of the Model P-7 should be performed in the sequence given and satisfactory results obtained before proceeding to the next section.

No scheduled, periodic maintenance of the Model P-7 is required. The test procedures should be used to establish the operational performance capability of the instrument and to assist in isolating a possible malfunction to a specific section. Use normal troubleshooting techniques to further isolate the fault to the component level. Replace the faulty component, then test and realign the unit as necessary. Figure 6-1 indicates the location of the main assemblies in the Model P-7 Programmer.

6.2 TEST EQUIPMENT REQUIRED

Table 6-1 lists test equipment and the minimum parameters required to conduct the minimum performance test of the Model P-7.

6.3. MINIMUM PERFORMANCE PROCEDURE

The minimum performance procedures may be used to establish the performance of the Model P-7 within acceptable limits. Activate the RESET switch before each step.

6.3.1 To Evaluate the Logic and Pen Control

a Set the controls of the Model P-7 as follows:

Band Select	All off
BANDWIDTH	1
DETECTOR FUNCTION	PEAK .05 HOLD TIME
REMOTE ATTEN (dB)	0 dB
PROGRAMMER MODE	LOCAL
MANUAL	Fully ccw
SWEEP TIME RANGE	MANUAL
SWEEP TIME VERNIER	Fully ccw
fo/f MIN	Fully ccw
Δf/f MAX	Fully ccw
SCAN MODE	FULL
DISPLAY MODE	RECORDER 24
PEN	NORMAL
X-Y RECORDER	OPERATE

Connect the X and Y inputs of the X-Y recorder to the X-Y RECORDER receptacles of the Model P-7. Calibrate the X-axis and Y-axis amplifiers of the X-Y recorder for zero and full-scale deflection using the X-Y RECORDER switch ZERO CAL and MAX CAL positions. Return the X-Y RECORDER switch to the OPERATE position. The pen should move from the bottom left to the top right of the page, then come to rest at the far left, 3/4 from the bottom of the page.

b. Depress the Band Select pushbuttons so that all are half lit. Repeatedly activate the START switch. Each of the Band Select indicators should become fully illuminated and then return to the

Table 6-1. Test Equipment Requirements

Instrument	Minimum Parameters		Recommended Model
Oscilloscope	Vertical sensitivity: Horizontal sweep time:	10 mV/div 0.5 ms	Tektronix Model 535
X-Y Recorder	X-axis sensitivity: Y-axis sensitivity:	0.2 V/inch 0.2 V/inch	Moseley Model 7030A
Volt-ohmmeter	Resistance measured:	<1 ohm	Triplett Model 630-APLK
DC Digital Voltmeter	Measurement range: Accuracy:	10 Vdc ±0.5 mV	Hewlett-Packard Model 3440A
Signal Generator	Frequency range: Output level:	1 kHz 2 V p-p	Hewlett-Packard Model 651B
Voltage Standard	Output voltage level: Accuracy:	3.333 Vdc ±0.5 mV	Fluke Model 343A

half lit condition, in sequence. The recorder pen should move to the beginning point of each of the sweeps according to the format defined in Figure 4-7.

c. Rotate the DISPLAY MODE switch to 16, depress the RESET switch, and repeat Step b. Only bands 2 thru 17 should be fully lit. Format is defined by Figure 4-6.

d. Rotate the DISPLAY MODE switch to 8, depress the RESET switch, and repeat Step b. Only the indicators for a single EMI/FI Meter should become illuminated. The format will be the same as Figure 4-5.

e. Rotate the DISPLAY MODE switch to 4 and repeat Step b. The first four pushbuttons should become lit and the pen should move to the lower left corner of each of the four quadrants. Format is defined by Figure 4-4.

f. Rotate the DISPLAY MODE switch to the 1 position and depress the RESET switch. Activate the START switch. Rotate the MANUAL control clockwise. The pen should track with the MANUAL control. Format is defined by Figure 4-3.

g. Disconnect the X-Y recorder and connect the digital voltmeter to the X-Y RECORDER X-DATA receptacle. Rotate the MANUAL control fully counterclockwise. The digital voltmeter should indicate 0 V ±20 mV.

h. Rotate the DISPLAY MODE switch to the 16 position and depress the RESET switch. Select bands 2 thru 5. Depress the START switch 4 times. After each activation of the START switch, the digital voltmeter should indicate: 0 V ±20 mV, +0.500 V ±20 mV, +1.000 V ±20 mV, and +1.500 V ±20 mV.

i. Rotate the DISPLAY MODE switch to the 1 position. Rotate the MANUAL control from fully counterclockwise to fully clockwise. The digital voltmeter should indicate 0 V ±10 mV and +1.966 V ±20 mV respectively.

j. Rotate the DISPLAY MODE switch to the 24 position. Rotate the MANUAL control from fully clockwise to fully counterclockwise. The digital voltmeter should indicate +0.284 V ±20 mV and 0.000 V ±10 mV respectively.

k. Rotate the DISPLAY MODE switch to the 4 position. Rotate the MANUAL control from fully counterclockwise to fully clockwise. The digital voltmeter should indicate 0 V ±10 mV and +0.950 V ±20 mV respectively.

l. Rotate the DISPLAY MODE switch to the 16 position. Select bands 2, 6, 10 and 14 only. Connect the digital voltmeter to the Y-DATA receptacle. Depress the START switch 4 times. After each activation of the START switch, the digital voltmeter should indicate +1.520 V ±20 mV, +1.020 V ±20 mV, +0.520 V ±20 mV, and ~~±0.002~~ .075 V ±20 mV.

m. Connect the X-Y recorder pen control to the Model P-7. Set the PEN switch to the DOWN position. The pen should drop onto the page.

n. Set the PEN switch to the NORMAL position. The pen should lift off the page.

o. Set the SWEEP TIME switch to the 30 SEC position. Activate the START switch. The pen should drop in approximately 3 seconds and a sweep should commence. Before the sweep time is completed,

(i) Depress the STOP switch. The STOP button should become illuminated; the sweep should stop and the pen should lift.

(ii) Deactivate the STOP switch. The pen should drop; the STOP light should extinguish and the sweep should resume.

(iii) Set the PEN switch to the UP position. The pen should lift.

(iv) Set the PEN switch to the NORMAL position. The pen should lower.

(v) Set the SWEEP TIME RANGE switch to the MANUAL position. The pen should lift.

6.3.2 To Evaluate the Tuning Voltage

a. Connect the digital voltmeter between pin L of the NM-7 PROGRAM receptacle and ground. Set the DISPLAY MODE switch to the RECORDER 1 or 4 position. Set the SWEEP TIME RANGE switch to the MANUAL position. Select the first band. Depress the START switch. Rotate the MANUAL control from fully counterclockwise to fully clockwise. The digital voltmeter should indicate from 0.00 V ±5 mV to +10.005 V ±5 mV.

b. Set the SCAN MODE switch to the Δf position. Set the fo/fMIN control to 5.00 and the Δf/fMAX control to 2.00. Operate the START switch. Rotate the MANUAL control from fully counterclockwise to fully clockwise. The digital voltmeter should indicate from +4.00 V ±20 mV to +6.00 V ±20 mV.

c. Set the SCAN MODE switch to the f MIN CAL position. Activate the START switch. Rotate the fo/fMIN control. The fo/fMIN indicator should agree with the digital voltmeter within ±20 mV.

d. Set the SCAN MODE switch to the f MAX CAL position. Set the fo/fMIN control to 0.00. Activate the START switch. Rotate the Δf/fMAX control. The Δf/fMAX control should agree with the digital voltmeter within ±20 mV.

e. Set the SCAN MODE switch to the OPERATE position. Set the fo/fMIN control to 3.00. Set the Δf/MAX control to 4.00. Activate the START switch. Rotate the MANUAL control from fully counterclockwise to fully clockwise. The digital voltmeter should indicate +3.00 V ±20 mV to +7.00 V ±20 mV.

6.3.3 To Evaluate The Band Select Control

a. Set the DISPLAY MODE switch to the RECORDER 24 position. Activate all of the Band Select switches. Set the SWEEP TIME RANGE switch to the MANUAL position. Activate the START switch repeatedly and measure the resistance between the connector pins indicated in

Table 6-2 as each band is selected. The measured resistance should be less than one ohm for each point of measurement.

Table 6-2. Band Select Pin Locations

Band	Receptacle	Pins
1	NM-7 PROGRAM	A and N
2	NM-17/27 PROGRAM	A and N
3	NM-17/27 PROGRAM	B and N
4	NM-17/27 PROGRAM	C and N
5	NM-17/27 PROGRAM	D and N
6	NM-17/27 PROGRAM	E and N
7	NM-17/27 PROGRAM	F and N
8	NM-17/27 PROGRAM	H and N
9	NM-17/27 PROGRAM	K and N
10	NM-37/57 PROGRAM	A and N
11	NM-37/57 PROGRAM	B and N
12	NM-37/57 PROGRAM	C and N
13	NM-37/57 PROGRAM	D and N
14	NM-37/57 PROGRAM	E and N
15	NM-37/57 PROGRAM	F and N
16	NM-37/57 PROGRAM	H and N
17	NM-37/57 PROGRAM	K and N
18	NM-67 PROGRAM	A and N
19	NM-67 PROGRAM	B and N
20	NM-67 PROGRAM	C and N
21	NM-67 PROGRAM	D and N
22	NM-67 PROGRAM	E and N
23	NM-67 PROGRAM	F and N
24	NM-67 PROGRAM	H and N

6.3.4 To Evaluate The Detector Function Control

a. Set the DETECTOR FUNCTION switch to the CAL position. Measure the resistance between pins g and J of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

b. Set the DETECTOR FUNCTION switch to the Fl position. Measure the resistance between pins f and J of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

c. Set the DETECTOR FUNCTION switch to the QP position. Measure the resistance between pins d and J of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

d. Set the DETECTOR FUNCTION switch to the PEAK (.05 SEC) position. Measure the resistance between pins c and J of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

e. Set the DETECTOR FUNCTION switch to the PEAK (.3 SEC) position. Measure the resistance between pins b and J of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

f. Set the DETECTOR FUNCTION switch to the PEAK (3.0 SEC) position. Measure the resistance between pins a and J of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

6.3.5 To Evaluate The Bandwidth Control

a. Set the BANDWIDTH switch to 1. Measure the resistance between pins M and X of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

b. Set the BANDWIDTH switch to 2. Measure the resistance between pins P and X of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

c. Set the BANDWIDTH switch to 3. Measure the resistance between pins S and X of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

d. Set the BANDWIDTH switch to 4. Measure the resistance between pins W and X of the four PROGRAM receptacles. The ohmmeter should indicate less than 1 ohm between all test points.

17/27 only

6.3.6 To Evaluate The Log Video Multiplexer

a. Connect the CRT X and Y DATA outputs to the X and Y-inputs of the oscilloscope. Rotate the DISPLAY MODE switch to the CRT position. Select Band 1. Set sweep time to 30 milliseconds. Activate START switch. Adjust oscilloscope controls to center the signals. A trace should appear on CRT screen with a marker blip occurring during retrace.

b. Rotate MANUAL control from fully counterclockwise to fully clockwise. The marker blip should move from the far left of the trace to the far right of the trace.

c. Connect the signal generator to the NM-7 LOG receptacle. Adjust the generator for a 1.0 kHz, 0.2 V peak-to-peak signal. The 1.0 kHz signal should appear on the CRT screen during the sweep, but should be blanked during retrace.

d. Deactivate Band One switch and activate the RESET switch. Select Band 2 and activate the START switch. Increase the signal generator level to 2 V peak-to-peak. Any observed 1.0 kHz signal should be less than 20 millivolts peak-to-peak.

e. Remove the signal generator from the NM-7 LOG receptacle and connect it to the NM-17/27 LOG receptacle. Reduce the amplitude to 0.2 volts peak-to-peak. Operate the Model P-7 in the 24 plots-per-page mode selecting, in turn, each of the 24 bands. The 1.0 kHz signal should appear only for those bands located in the Model NM-17/27 EMI/FI Meter.

f. Remove the signal generator from the NM-17/27 LOG receptacle and connect it to the NM-37/57 LOG receptacle. Repeat Step e. The 1.0 kHz signal should appear only for those bands located in the NM-37/57 EMI/FI Meter.

g. Remove the signal generator from the NM-37/57 LOG receptacle and connect it to the NM-67 LOG receptacle. Repeat Step e. The 1.0 kHz signal should appear only for those bands located in the Model NM-67 EMI/FI Meter.

6.3.7 To Evaluate The Auxiliary Multiplexer

a. Attach the signal generator to the NM-7 AUX receptacle. Adjust the signal for 1.0 kHz, 2 volts peak-to-peak. Monitor the AUX OUTPUT receptacle with the oscilloscope. Operate the Model P-7 in the 24 plots-per-page mode, selecting, in turn, each of the 24 bands. The 1.0 kHz signal should be displayed only when band 1 is selected.

b. Remove the signal generator from the NM-7 AUX receptacle and connect it to the NM-17/27 AUX receptacle. Repeat Step a. The 1.0 kHz signal should be displayed only for those bands located in the Model NM-17/27 EMI/FI Meter.

c. Remove the signal generator from the NM-17/27 AUX receptacle and connect it to the NM-37/57 AUX receptacle. Repeat Step a. The 1.0 kHz signal should be displayed only for those bands located in the Model NM-37/57 EMI/FI Meter.

d. Remove the signal generator from the NM-37/57 AUX receptacle and connect it to the NM-67 AUX receptacle. Repeat Step a. The 1.0 kHz signal should be displayed only for those bands lo cated in the Model NM-67 EMI/FI Meter.

6.3.8 To Evaluate The Simultaneous Fl Multiplexer

a. Connect the signal generator to pin k of the NM-7 PROGRAM receptacle. Operate the P-7 in the 24 plots-per-page mode. Set the SWEEP TIME RANGE switch to the MANUAL position, selecting in turn each of the 24 bands. Monitor the SIMULTANEOUS Fl receptacle with the oscilloscope. Adjust the signal generator for 1.0 kHz, 2 volts peak-to-peak. The 1.0 kHz signal should be displayed only for the first band.

b. Remove the generator from the NM-7 PROGRAM receptacle and connect it to pin k of the NM-17/27 PROGRAM receptacle. Repeat Step a. The 1.0 kHz signal should be present only for those bands located in the Model NM-17/27 EMI/FI.

c. Remove the generator from the NM-17/27 PROGRAM receptacle and connect it to pin k of the NM-37/57 PROGRAM receptacle. Repeat Step a. The 1.0 kHz signal should be present only for those bands located in the Model NM-37/57 EMI/FI Meter.

d. Remove the generator from the NM-37/57 PROGRAM receptacle and connect it to pin k of the NM-67 PROGRAM receptacle. Repeat Step a. The 1.0 kHz signal should be present only for those bands located in the Model NM-67 EMI/FI Meter.

6.3.9 To Evaluate The Remote Digital Display

Frequency Multiplexer

a. Monitor pin P of the REMOTE DIGITAL DISPLAY receptacle with the oscilloscope. Connect the signal generator to pin T of the NM-7 PROGRAM receptacle and adjust for 2 V peak-to-peak and 1.0 kHz. Operate the Model P-7 in the 24 plots-per-page mode. Set the SWEEP TIME RANGE switch to the MANUAL position, selecting in turn each of the 24 bands. The 1.0 kHz signal should be present only when band 1 is being swept.

b. Disconnect the signal generator from the NM-7 PROGRAM receptacle and connect it to pin T of the NM-17/27 PROGRAM receptacle. Repeat Step a. The 1.0 kHz signal should be present only for the bands located in the Model NM-17/27 EMI/FI Meter.

c. Disconnect the signal generator from the NM-17/27 PROGRAM receptacle and connect it to pin T of the NM-37/57 PROGRAM receptacle. Repeat Step a. The 1.0 kHz signal should be present only for the bands located in the Model NM-37/57 EMI/FI Meter.

d. Disconnect the signal generator from the NM-37/57 PROGRAM receptacle and connect it to pin T of the NM-67 PROGRAM receptacle. Repeat Step a. The 1.0 kHz signal should be present only for the bands located in the Model NM-67 EMI/FI Meter.

dB Readout Multiplexer

e. Monitor pin S of the REMOTE DIGITAL DISPLAY receptacle with the oscilloscope. Connect the signal generator to pin V of the NM-7 PROGRAM receptacle and adjust for 1.0 kHz and 2 volts peak-to-peak. Operate the Model P-7 in the 24 plots-per-page mode. Set the SWEEP TIME RANGE switch to the MANUAL position, selecting in turn each of the 24 bands. The 1.0 kHz signal should be present only for the first band.

f. Disconnect the signal generator from the NM-7 PROGRAM receptacle and connect it to pin V of the NM-17/27 PROGRAM receptacle. Repeat Step e. The 1.0 kHz signal should be present only for the bands located in the Model NM-17/27 EMI/FI Meter.

g. Disconnect the signal generator from the NM-17/27 PROGRAM receptacle and connect it to pin V of the NM-37/57 PROGRAM receptacle. Repeat Step e. The 1.0 kHz signal should be present only for the bands located in the Model NM-37/57 EMI/FI Meter.

h. Disconnect the signal generator from the NM-37/57 PROGRAM receptacle and connect it to pin V of the NM-67 PROGRAM receptacle. Repeat Step e. The 1.0 kHz signal should be present only for the bands located in the Model NM-67 EMI/FI Meter.

Band Select Bits

i. Operate the Model P-7 in the 24 plots-per-page mode. Set the SWEEP TIME RANGE switch to the MANUAL position. Depress the START switch to advance to the selected band. Monitor pins A, B, C, D, and E of the REMOTE DIGITAL DISPLAY receptacle with the volt-ohmmeter. A 1 kilohm, 1/4 watt resistor is to be connected between the probe contact and +5 volts (+5 volts is available at pin U of the ANTENNA SWITCH AND ATTENUATOR receptacle.) For each of the 24 bands, a distinct 5-bit binary count code should

be apparent (See Table 6-3), with 00000 indicating the first selected band (Pin A represents 2^0, B for 2^1, C for 2^2, D for 2^3, and E for 2^4). For any selected band, the binary number should correspond to the band number. A "1" is +2.0 volts or more and a "0" is +0.8 volts or less.

Table 6-3. Band Select Bit Binary Code

Band	2^4	2^3	2^2	2^1	2^0
1	0	0	0	0	0
2	0	0	0	0	1
3	0	0	0	1	0
4	0	0	0	1	1
5	0	0	1	0	0
6	0	0	1	0	1
7	0	0	1	1	0
8	0	0	1	1	1
9	0	1	0	0	0
10	0	1	0	0	1
11	0	1	0	1	0
12	0	1	0	1	1
13	0	1	1	0	0
14	0	1	1	0	1
15	0	1	1	1	0
16	0	1	1	1	1
17	1	0	0	0	0
18	1	0	0	0	1
19	1	0	0	1	0
20	1	0	0	1	1
21	1	0	1	0	0
22	1	0	1	0	1
23	1	0	1	1	0
24	1	0	1	1	1

Attenuator Control ≈5.0V @ 6

j. Rotate the REMOTE ATTEN(dB) switch to 0 dB. Monitor pins G, H, J, K, L, and M of the REMOTE DIGITAL DISPLAY receptacle with the volt-ohmmeter, using a 1 kilohm, ±10% 1/4 watt resistor between the probe and +5 volts (available at pin U of the ATTENNA SWITCH AND ATTENUATOR receptacle). Voltage should be ±0.8 volts maximum at pin G. Pins H, J, K, L, and M should be +2.0 volts ~~minimum~~ MAX. 5.0V

k. Rotate the REMOTE ATTEN (dB) switch to 20 dB. Repeat Step j. Voltage should be ~~+0.8~~ volts maximum at pin H and +2.0 volts minimum at pins G, J, K, L, and M. ≈5.0 @ H 5.0V

l. Rotate the REMOTE ATTEN (dB) switch to 40 dB. Repeat Step j. Voltage should be +0.8 volts maximum at pin J and +2.0 volts minimum at pins G, H, K, L, and M. ≈5.0 @ J

m. Rotate the REMOTE ATTEN (dB) switch to 60 dB. Repeat Step j. Voltage should be +0.8 volts maximum at pin K and +2.0 volts minimum at pins G, H, J, L, and M. ≈5.0 @ K

n. Rotate the REMOTE ATTEN (dB) switch to 80 dB. Repeat Step j. Voltage should be +0.8 volts maximum at pin L and +2.0 volts minimum at pins G, H, J, K, and M. ≈5.0 @ L

o. Rotate the REMOTE ATTEN (dB) switch to 100 dB. Repeat Step j. Voltage should be +0.8 volts maximum at pin M and +2.0 volts minimum at pins G, H, J, K, and L. ≈5.0 @ M

D. C. Voltage Test

p. Measure the voltage at pins S and T of the REMOTE DIGITAL DISPLAY receptacle. Voltage should be +15 V ±1% at pin S and −15 V ±1% at pin T.

6.3.10 To Evaluate the Antenna Switch

a. Band Select Bits

Test procedure is identical to that for remote digital display test, Paragraph 6.3.9-e. Results should be identical, monitoring the ANTENNA SWITCH AND ATTENUATOR receptacle in lieu of the REMOTE DIGITAL DISPLAY receptacle.

b. Attenuator Control

Test procedure is identical to that for remote digital display test, Paragraphs 6.3.9-j thru 6.3.9-o. Results should be identical, monitoring the ANTENNA SWITCH AND ATTENUATOR receptacle in lieu of the REMOTE DIGITAL DISPLAY receptacle.

c. Dc Voltage Tests

Measure the voltage at pins S, T and U of the ANTENNA SWITCH AND ATTENUATOR receptacle with respect to the chassis. Pin S should be +15 V ±1%; pin T should be −15 V ±1%; pin U should be +5 V ±5%.

6.4 ALIGNMENT AND ADJUSTMENT PROCEDURES

Refer to Figures 6-2 thru 6-6.

6.4.1 Disassembly Procedures

Each of the two side cover panels is held in place by four No. 4 flat-head screws that are externally accessible. The top and bottom cover panels are each held by ten No. 10 socket-head cap screws that are accessible after removal of the side cover panels. Proceed as follows:

a. Remove four 4-40 X 3/8 flat-head screws that secure each side cover panel.

b. Remove the side cover panels, exposing the side frames. The socket-head cap screws holding the top and bottom cover panels are now accessible.

c. Remove the twenty 10-32 X 3/4 socket-head cap screws that secure the top and bottom cover panels to the side frames.

d. Remove the top and bottom cover panels from the Model P-7.

The subassemblies are accessible from the top of the instrument and require no special instructions for removal.

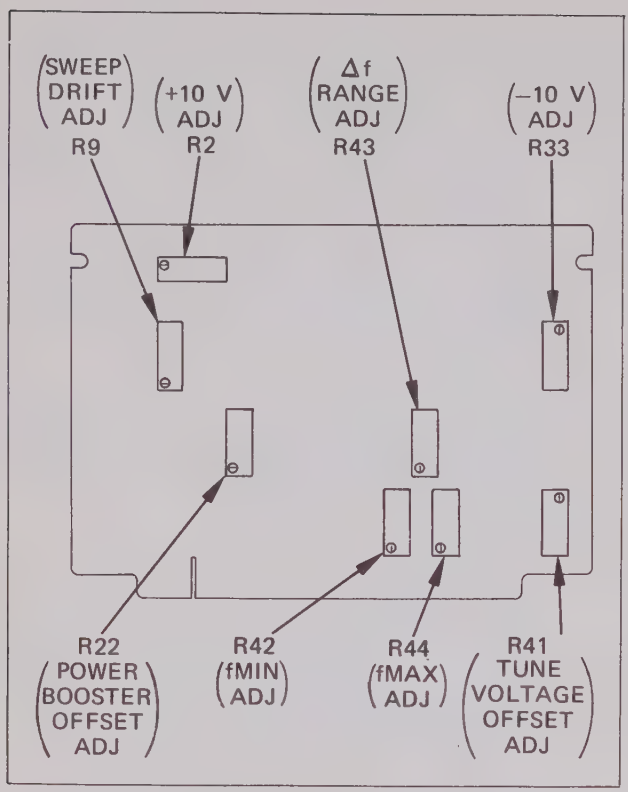


Figure 6-2.
Trimmer Locations, Sweep Generator Assembly, A1

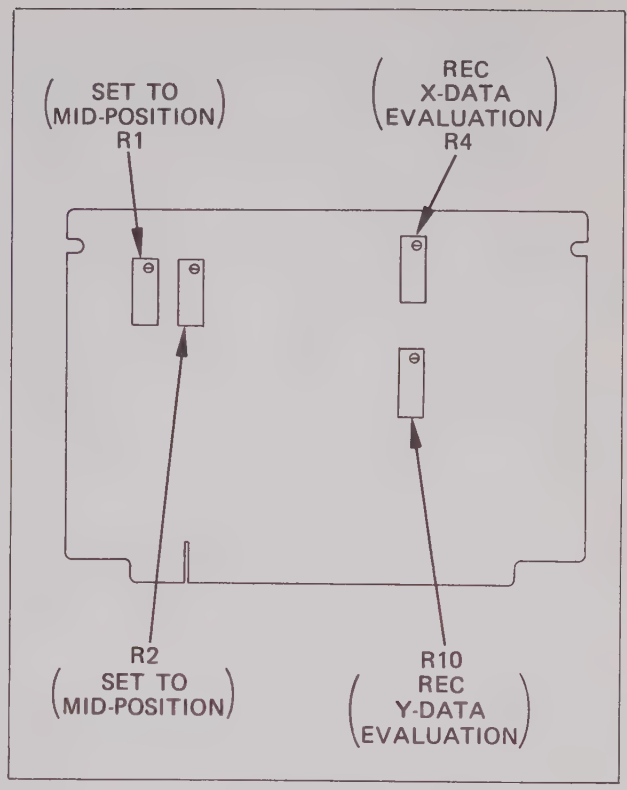


Figure 6-3.
Trimmer Locations, D/A Converter Assembly, A2

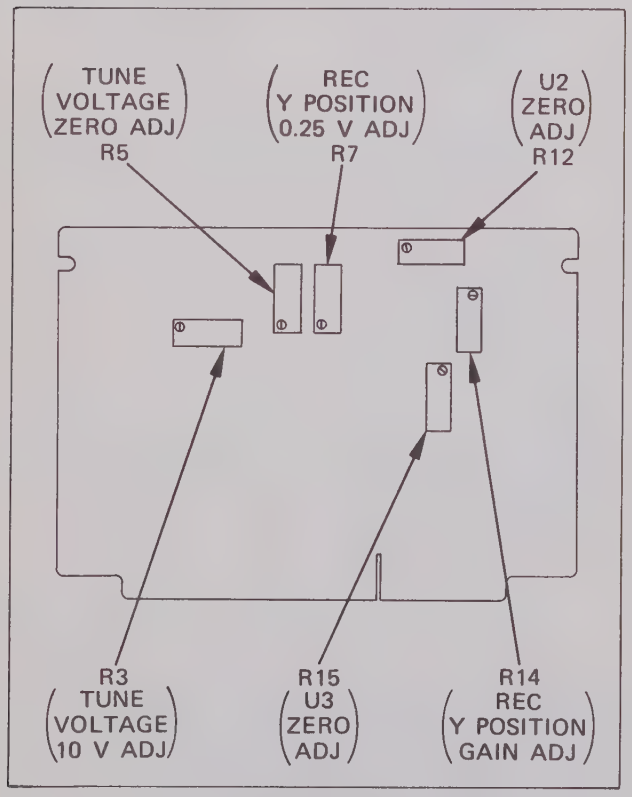


Figure 6-4.
Trimmer Locations, Analog Multiplexer Assembly, A8

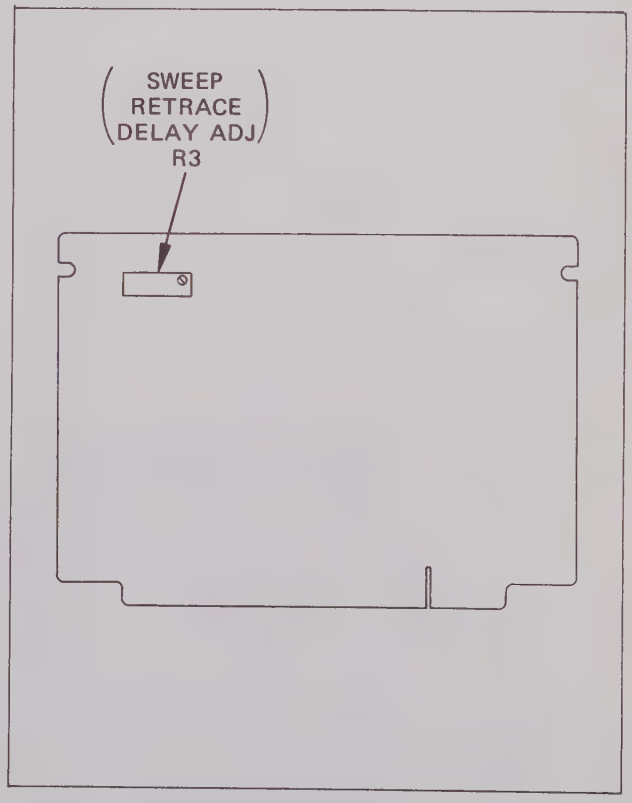


Figure 6-5.
Trimmer Locations, Logic Control Assembly, A10

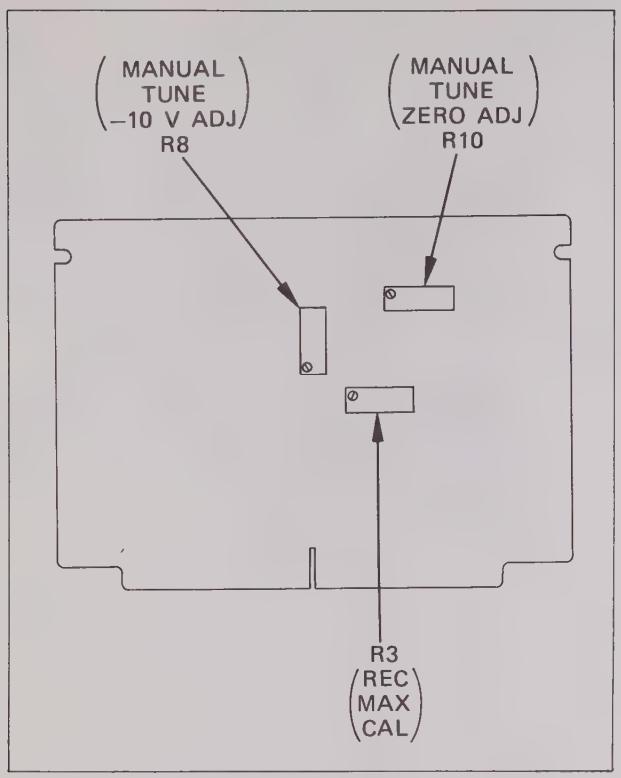


Figure 6-6.
Trimmer Locations,
Calibration Reference Generator Assembly, A15

6.4.2 Sweep Generator Alignment

a. Remove A1 from the card cage and reinstall A1 with the card extender.

b. *Alignment of the Reference Voltages*

Monitor the +10 volt generator output at A1-13. Adjust A1R2 for an indication of +10.000 V ±2 mV. Monitor the −10 volt generator output at A1-10. Adjust A1R33 for an indication of −10.000 V ±2 mV.

c. *Sweep Circuit Drift Alignment*

Monitor A1U3-6, the output of the integrator circuit. Adjust the SWEEP TIME RANGE controls for a 30-second sweep. Set the DISPLAY MODE switch to the RECORDER 1 position. Initiate a sweep by activating the START switch. After approximately 10 seconds, activate the STOP switch. Adjust A1R9 for a minimum rate of change of the monitored voltage. An acceptable minimum for this drift is 5 mV maximum/sec.

d. *Power Booster Offset Alignment*

Depress the STOP switch. Depress the RESET switch. Observe the voltage at A1U3-6. Adjust A1R22 such that the voltage at A1-H is within 1 mV of the voltage at A1U3-6.

e. *Alignment of the Tune Voltage Summing Circuit Offset Alignment*

Place the SCAN MODE switch in the FULL position. Activate the RESET switch. Connect the digital voltmeter to A1-17. Set the SWEEP TIME RANGE switch to 30 seconds. Adjust A1R41 until the voltmeter indicates 0.000 V ±5 mV.

f. *Summing Network Scaling Adjustments*

Set the SCAN MODE switch to the fMIN CAL position. Rotate the Δf/fMAX control fully counterclockwise. Rotate the fo/fMIN control fully clockwise. Adjust A1R42 until A1-17 indicates −10.000 V ±5 mV. Set the SCAN MODE switch to the fMAX CAL position. Rotate the Δf/fMIN control fully counterclockwise. Rotate the Δf/fMAX control fully clockwise. Adjust A1R44 until the voltage at A1-17 is −10.000 V ±5 mV. Place the SCAN MODE switch in the Δf position. Rotate the fo/fMIN and the Δf/fMAX controls fully clockwise. Adjust A1R43 until the voltage at A1-17 is −5.000 V ±5 mV. Set the SCAN MODE switch to FULL.

g. *Manual Tune Control Buffer Adjustment*

Rotate the MANUAL control fully counterclockwise. Adjust A15R10 for 0.000 V ±5 mV at A15-18. Rotate the MANUAL control fully clockwise. Adjust A15R8 for −10.000 V ±5 mV at A15-18.

6.4.3 Digital-to-Analog Converter Alignment

a. Set the DISPLAY MODE switch to the RECORDER 1 position. Set the X-Y RECORDER switch to the ZERO CAL position. Activate the RESET switch. Adjust A2R4 until the voltage at A2-16 is within 4 millivolts of the voltage at A2-21. Adjust A2R10 until the voltage at A2-17 is within 4 millivolts of the voltage at A2-20.

b. Set A2R1 and A2R2 to mid-position.

6.4.4 Analog Multiplexer Alignment

a. *Alignment of the Tune Voltage Demuliplexer*

Set the SCAN MODE switch to the FULL position. Set the SWEEP TIME RANGE switch to the MANUAL position. Rotate the MANUAL control fully counterclockwise. Adjust A8R5 until the voltage at A8U1-6 is −10 V ±5 mV. Rotate the MANUAL control fully clockwise. Adjust A8R3 until the voltage at A8U1-6 is +10.050 V ±5 mV.

b. *Alignment of the Y-Data Multiplexer*

Connect pin Y of the NM-7 PROGRAM receptacle to ground. Set the SWEEP TIME RANGE switch to the MANUAL position and the DISPLAY MODE switch to the RECORDER 1 position. Select Band 1 and activate the START switch. Rotate A8R7 until the voltage at the moveable contact of A8R7 measures 0.0 volts. Adjust A8R15 until the voltage at A8U3-6 is within 10 millivolts of the voltage at A8U3-3. Adjust A8R12 until the voltage at A8U2-6 is 0.000 V ±5 mV. Disconnect the ground from pin Y of the NM-7 PROGRAM receptacle. Connect the voltage reference to pin Y of the NM-7 PROGRAM receptacle and adjust the output for +2.000 V ±5 mV. Adjust A8R14 until the voltage at the X-Y RECORDER Y DATA receptacle is +1.750 V ±5

mV. Disconnect voltage reference and pin Y of the NM-7 PROGRAM receptacle and adjust A8R7 for +0.250 V ±5 mV at the X-Y RECORDER Y DATA receptacle. Disconnect ground from pin Y.

c. *Retrace Delay Adjustment*

Set the DISPLAY MODE switch to the CRT position. Set the SWEEP TIME RANGE controls for 30 milliseconds. Activate the Model P-7 by depressing the START switch. Monitor A1-H with the oscilloscope. Adjust A10R3 for a delay of 1.2 milliseconds between the end of the sweep retrace and the beginning of the next sweep, using Figure 6-7 as a guide.

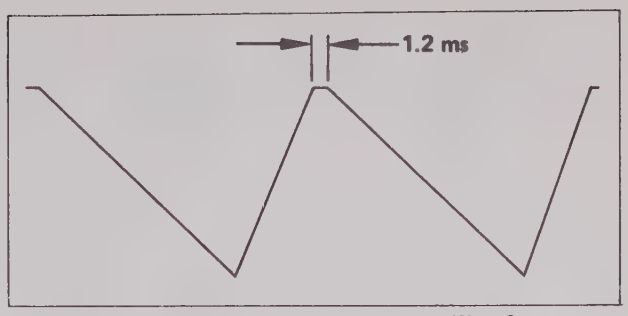


Figure 6-7. Sweep Generator Delay Waveform

d. *Calibration Reference Generator Adjustment*

Adjust A15R3 for +2.000 V ±20 mV at the X-Y RECORDER Y-DATA receptacle with the X-Y RECORDER switch at the MAX CAL postion. Check for +2.000 V ±20 mV at the X-Y RECORDER X-DATA receptacle.

Section VII

REPLACEABLE PARTS

7.1 INTRODUCTION

This section contains information for ordering replacement parts. Table 7-1 lists the parts of the main assembly and chassis. Tables 7-2 and 7-3 refer to miscellaneous parts and supplied accessories, respectively. Tables 7-4 thru 7-18 list the parts of the various assemblies of the Model P-7. Parts are listed in the alpha-numeric order of their reference designators and indicate the description, Singer part number, manufacturer of the part in a five-digit code, and manufacturer's part number. Table 7-19 lists the manufacturers in numerical code number order.

Table 7-1. Parts List for Main Assemblies and Chassis

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
A1	Assembly, Sweep Generator	3-004740-001	88869	
A2	Assembly, Digital to Analog	3-004741-001	88869	
A3	Assembly, Relay Driver	3-004742-001	88869	
A4	Assembly, Relay Driver	3-004742-001	88869	
A5	Assembly, Band Decoder and Digital Multiplexer	3-004743-001	88869	
A6	Assembly, Band Decoder and Digital Multiplexer	3-004743-001	88869	
A7	Assembly, Band Decoder and Digital Multiplexer	3-004743-001	88869	
A8	Assembly, Analog Multiplexer	3-004744-001	88869	
A9	Assembly, Receiver Decode and Relay Driver	3-004745-001	88869	
A10	Assembly, Logic Control	3-004746-001	88869	
A11	Assembly, Digital Interface	3-004747-001	88869	
A12	Assembly, Digital Pen Control	3-004748-001	88869	
A13	Assembly, Auxiliary Multiplexer and Attenuator Control	3-004749-001	88869	
A14	Assembly, Sweep Select	3-004750-001	88869	
A15	Assembly, Calibration Voltage Source, Digital Buffer and Starter Logic	3-004751-001	88869	
A16	Assembly, Auxiliary Multiplexer and Attenuator Control	3-004749-002	88869	
C1	Capacitor, fixed, electrolytic, 3.3 uF, ±10%, 15 V dc	1-900057-171	56289	150D335X9015A2
C2	Capacitor, fixed, ceramic, 0.02 uF, ±20%, 25 V dc	1-900076-002	72982	5835-000-Y5U0-203Z
CR1	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR2	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR3	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR4	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR5	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR6	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR7	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR8	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR9	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR10	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR11	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR12	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR13	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR14	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR15	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR16	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR17	Diode, silicon, Vr = 50 V, If = 1 A	1-813001-001	04713	1N4001
CR18	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR19	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR20	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR21	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
CR22	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR23	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR24	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR25	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
CR26	Diode, silicon, Vr = 50 V, If = 1 A	1-913001-001	04713	1N4001
DS1	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS2	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS3	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS4	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS5	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS6	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS7	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS8	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS9	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS10	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS11	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS12	Lamp, incandescent, T 1-3/4, 5 V, 115, mA	1-925018-001	03508	7335
DS13	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS14	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS15	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS16	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS17	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS18	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS19	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS20	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS21	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
DS22	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS23	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS24	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS25	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
DS26	Lamp, incandescent, T 1-3/4, 5 V, 115 mA	1-925018-001	03508	7335
F1	Fuse, slo-blo, 1.5 A	1-924005-122	75915	31301.5
F2	Fuse, slo-blo, 3 A	1-924005-127	75915	313003
FL1	Filter, power line	1-910201-001	0000J	3EF1
J1	Not used			
J2	Not used			
J3	Not used			
J4	Not used			
J5	Not used			
J6	Not used			
J7	Not used			
J8	Not used			
J9	Not used			
J10	Not used			
J11	Not used			
J12	Not used			
J13	Not used			
J14	Not used			
J15	Not used			
J16	Not used			
J17	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J18	Connector, jack, 41 pin, box mounting	1-910202-007	71468	KPTM02A20-41P
J19	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J20	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J21	Connector, jack, 41 pin, box mounting	1-910202-007	71468	KPTM02A20-41P
J22	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J23	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J24	Connector, jack, 41 pin, box mounting	1-910202-007	71468	KPTM02A20-41P
J25	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J26	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J27	Connector, jack, 41 pin, box mounting	1-910202-007	71468	KPTM02A20-41P
J28	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J29	Connector, jack, 55 pin, box mounting	1-910202-008	71468	KPTM02A22-55P

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
J30	Connector, jack, 19 pin, box mounting	1-910202-004	71468	KPTM02A14-19P
J31	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J32	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J33	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J34	Connector, jack, phone, 3-conductor	1-910152-001	82389	13B
J35	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J36	Connector, jack, 19 pin, box mounting	1-910202-004	71468	KPTM02A14-19P
J37	Connector, jack, phone, 3-conductor	1-910152-001	82389	13B
J38	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
J39	Connector, jack, BNC, bulkhead	1-910132-001	11636	UG-1094A/U
K1	Relay, 2 pole, 2 position, Coil: 6 V dc, 240 mW, 36 ohm	1-942023-001	09026	BR12-36B2
PS1A1	Assembly, +5 V logic power supply	1-968006-001	0000K	22C-100
PS1A2	Assembly, +5 V logic power supply	1-968006-001	0000K	22C-100
PS1A3	Assembly, +15 V power supply	1-968005-001	0000K	22A-300
PS1A4	Assembly, -15 V power supply	1-968005-001	0000K	22A-300
R1	Resistor, variable, cermet, 1 kilohm, ±10%, 1 W	1-945105-007	80294	3059J-1-102M
R2	Resistor, variable, cermet, 1 kilohm, ±10%, 1 W	1-945105-007	80294	3059J-1-102M
R2	Resistor, variable, cermet, 1 kilohm, ±10%, 1 W	1-945105-007	80294	3059J-1-102M
R4	Resistor, variable, cermet, 1 kilohm, ±10%, 1 W	1-945105-007	80294	3059J-1-102M
R5	Resistor, variable, composition, 10 kilohm, ±10%, 2 W	1-945078-108	01121	JA1N048P103UA
R6	Resistor, variable, wirewound, 10 kilohm, ±3%, 1.5 W	1-945102-002	80740	7216R-10K-L.25
R7A/R7B	Resistor/variable assembly (R7A) Wirewound, 2 kilohm, ±3%, 1.5 W (R7B) Wirewound, 2 kilohm, ±3%, 1.5 W	1-945102-001	80740	7216R2K(1) R2K(1)L.25
R8	Resistor, variable, wirewound, 2 kilohm, ±3%, 1.5 W	1-945102-003	80740	7216R-2K-L.25
R9	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R10	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R11	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R12	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R13	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R14	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R15	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R16	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R17	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R18	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R19	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R20	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R21	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R22	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R23	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R24	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R25	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R26	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R27	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R28	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R29	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R30	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R31	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R32	Resistor, fixed, composition, 20 ohm, ±5%, 1/4 W	1-945000-121	01121	CB2005
R33	Resistor, fixed, film, 75 ohm, ±1%, 1/10 W	1-945027-085	07115	RN55D7500F
R34	Resistor, fixed, film, 75 ohm, ±1%, 1/10 W	1-945027-085	07115	RN55D7500F
R35	Resistor, fixed, film, 75 ohm, ±1%, 1/10 W	1-945027-085	07115	RN55D7500F
R36	Resistor, fixed, film, 75 ohm, ±1%, 1/10 W	1-945027-085	07115	RN55D7500F
R37	Resistor, fixed, composition, 47 ohm, ±5%, 1/4 W	1-945000-130	01121	CB4705
R38	Resistor, fixed, composition, 47 ohm, ±5%, 1/4 W	1-945000-130	01121	CB4705

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R39	Resistor, fixed, composition, 47 ohm, ±5%, 1/4 W	1-945000-130	01121	CB4705
S1	Switch, slide, 2 poles, 2 positions	1-951003-001	82389	46206LF
S2	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S3	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S4	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S5	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S6	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S7	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S8	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S9	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S10	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S11	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S12	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S13	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S14	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S15	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S16	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S17	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S18	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S19	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S20	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S21	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S22	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S23	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S24	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
S25	Switch, illuminated, white lens, push-push, 1 pole, 2 positions	1-951041-001	07137	PBL-A-ASA-01
S26	Switch, illuminated, red lens, push-push, 1 pole, 2 position	1-951041-003	07137	PBL-A-ASA-01
S27	Switch, toggle, 1 pole, 2 position	1-951042-001	09353	7109PDZGE
S28	Switch, illuminated, yellow lens, push-push, 1 pole, 1 position	1-951041-002	07137	PBL-A-ASA-04
S29	Switch, toggle, 1 pole, 1 position	1-951042-001	09353	7109PDZGE
S30	Switch, rotary, 2 pole, 6 position	2-403560-001	88869	
S31	Switch, rotary, 3 pole, 5 position	2-403558-001	88869	
S32	Switch, rotary, 2 pole, 6 position	2-403560-001	88869	
S33	Switch, rotary, 1 pole, 4 position	2-403555-001	88869	
S34	Switch, toggle, 1 pole, 1 position	1-951042-002	09353	7103PDZGE
S35	Switch, rotary, 3 pole, 3 position	2-403557-001	88869	
S36	Switch, rotary, 5 pole, 5 position	2-403559-001	88869	
S37	Switch, rotary, 5 pole, 2 position	2-403563-001	88869	
S38	Switch, rotary, 2 pole, 6 position	2-403560-001	88869	
T1	Transformer, 115 V/230 V primary	3-403596-001	0000K	PK1064
TB1	Terminal board, barrier block, 11 terminals	1-941046-001	71785	11-164
X1	Socket, printed circuit board extender, 22 pin	1-910203-001	05574	2VH22/1AN3
XA1	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA2	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA3	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA4	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA5	Socket, printed, circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA6	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA7	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA8	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA9	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA10	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA11	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA12	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3

Table 7-1. Parts List for Main Assemblies and Chassis (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
XA13	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA14	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA15	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XA16	Socket, printed circuit board, 22 pin	1-910203-001	05574	2VH22/1AN3
XF1	Fuseholder	1-924007-001	75915	341001
XF2	Fuseholder	1-924007-001	75915	341001

Table 7-2. Parts List for Miscellaneous Parts

Quantity	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
1	Card extender, circuit board	4-103189-001	88869	
1	Extractor, circuit board	2-103188-001	88869	
1	Knob, black	1-935021-001	0000H	RSSN-125SP-2 BLK
9	Knob, black	1-935023-001	0000H	RSSN-70TSL-2 BLK
1	Wrench, Allen, No. 8	1-964289-008	88869	
1	Wrench, Allen, No. 10	1-964287-010	88869	

Table 7-3. Parts List for Supplied Accessories

Quantity	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
1	Power cord, a.c., 7 1/2 ft.	1-910166-001	70903	KH7375
1	Instruction manual	1-500783-257	88869	
2	Brackets, rack mounting	3-103317-001	88869	
4	Screws, flat-head, No. 10-32 x 1/2	1-964064-265	88869	

Table 7-4. Parts List for Sweep Generator Assembly, A1

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, epoxy dipped, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
C2	Capacitor, fixed, mica, 100 pF, ±5%, 500 V dc	1-900072-020	04062	SCDM10-101J
C3	Not used			
C4	Capacitor, fixed, plastic, 2.0 uF, ±20%, 50 V dc	1-900123-001	24152	22RA205
C5	Capacitor, fixed, epoxy dipped, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
C6	Capacitor, fixed, mica, 470 pF, ±5%, 500 V dc	1-900072-032	04062	SCDM10-471J
C7	Capacitor, fixed, ceramic, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
C8	Capacitor, fixed, mica, 100 pF, ±5%, 500 V dc	1-900072-020	04062	SCDM10-101J
CR1	Diode, zener, 8.2 V, ±10%, 400 mW	1-913078-001	04713	1N959
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	01295	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	01295	lN4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	01295	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
R1	Resistor, fixed, film, 3.01 kilohm, ±10%, 1/10 W	1-945027-239	07115	RN55D3011F
R2	Resistor, variable, cerment, 2 kilohm, ±10%, 1/2 W	1-945104-003	80294	3282W-1-102
R3	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-114	01121	CB1005
R4	Resistor, fixed, film, 3.57 kilohm, ±1%, 1/10 W	1-945027-246	07115	RN55D3571F
R5	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R6	Resistor, fixed, composition, 1 megohm, ±5%, 1/4 W	1-945000-234	01121	CB1055
R7	Resistor, fixed, film, 49.9 ohm, ±1%, 1/10 W	1-945027-068	07115	RN55D49R9F
R8	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R9	Resistor, variable, cermet, 1 kilohm, ±10%, 1/2 W	1-945104-003	80294	3282W-1-102
R10	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R11	Resistor, fixed, composition, 15 kilohm, ±5%, 1/4 W	1-945000-190	01121	CB1535
R12	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R13	Resistor, fixed, film, 49.9 ohm, ±1%, 1/10 W	1-945027-068	07115	RN55D49R9F

Table 7-4. Parts List for Sweep Generator Assembly, A1 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R14	Resistor, fixed, composition, 15 kilohm, ±5%, 1/4 W	1-945000-190	01121	CB1535
R15	Resistor, fixed, composition, 150 kilohm, ±5%, 1/4 W	1-945000-214	01121	CB1545
R16	Resistor, fixed, composition, 1.5 megohm, ±5%, 1/4 W	1-945000-238	01121	CB1555
R17	Resistor, fixed, composition, 15 megohm, ±5%, 1/4 W	1-945000-262	01121	CB1565
R18	Resistor, fixed, composition, 1.5 kilohm, ±5%, 1/4 W	1-945000-166	01121	CB1525
R19	Resistor, fixed, composition, 470 kilohm, ±5%, 1/4 W	1-945000-226	01121	CB4745
R20	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R21	Resistor, fixed, composition, 100 kilohm, ±5%, 1/4 W	1-945000-210	01121	CB1045
R22	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R23	Resistor, fixed, composition, 1.1 kilohm, ±5%, 1/4 W	1-945000-163	01121	CB1125
R24	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R25	Resistor, fixed, composition, 1 megohm, ±5%, 1/4 W	1-945000-234	01121	CB1065
R26	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R27	Resistor, fixed, film, 19.6 kilohm, ±1%, 1/10 W	1-945027-317	07115	RN55D19R6F
R28	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R29	Resistor, fixed, film, 20 kilohm, ±1%, 1/10 W	1-945027-318	07115	RN55D2002F
R30	Resistor, fixed, film, 20 kilohm, ±1%, 1/10 W	1-945027-318	07115	RN55D2002F
R31	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R32	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R33	Resistor, variable, cermet, 1 kilohm, ±10%, 1/2 W	1-945104-003	80294	3282W-1-102
R34	Resistor, fixed, composition, 3.3 kilohm, ±5%, 1/4 W	1-945000-174	01121	CB3325
R35	Resistor, fixed, film, 200 kilohm, ±1%, 1/10 W	1-945027-414	07115	RN55D2003F
R36	Resistor, fixed, composition, 47 kilohm, ±5%, 1/4 W	1-945000-202	01121	CB4735
R37	Resistor, fixed, film, 196 kilohm, ±1%, 1/10 W	1-945027-413	07115	RN55D1963F
R38	Resistor, fixed, film, 392 kilohm, ±1%, 1/10 W	1-945027-442	07115	RN55D3923F

Table 7-4. Parts List for Sweep Generator Assembly, A1 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R39	Resistor, fixed, film, 196 kilohm, ±1%, 1/10 W	1-945027-413	07115	RN55D1963F
R40	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R41	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R42	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R43	Resistor, variable, cermet, 20 kilohm, ±10%, 1/2 W	1-945104-007	80294	3282W-1-203
R44	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R45	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R46	Resistor, fixed, composition, 5.6 kilohm, ±5%, 1/4 W	1-945000-180	01121	CB5625
R47	Not used			
R48	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
U1	Integrated circuit, voltage regulator	1-926036-003	07263	uA723DC
U2	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U3	Integrated circuit, operational amplifier	1-926036-002	07263	741C
U4	Integrated circuit, dpst analog switch	1-926065-001	27014	AH2114CG
U5	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U6	Integrated circuit, voltage comparator	1-926064-002	27014	LM211H
U7	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U8	Integrated circuit, dual j-k flip-flop	1-926007-012	01295	SN74107N
U9	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U10	Integrated circuit, power boster	1-926063-001	04713	MC1438R
U11	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U12	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U13	Integrated circuit, operational amplifier	1-926064-001	27014	LM208H
U14	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C

Table 7-5. Parts List for Digital-to-Analog Converter Assembly, A2

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, mica, 100 pF, ±5%, 500 V dc	1-900072-020	04062	SCDM10-101J
C2	Capacitor, fixed, mica, 100 pF, ±5%, 500 V dc	1-900072-020	04062	SCDM10-101J
C3	Capacitor, fixed, ceramic, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
C4	Capacitor, fixed, ceramic, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR5	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR6	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR7	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR8	Diode, silicon, Vr = 75 V, If = 10 mA	1-91300-7002	03508	1N4148
CR9	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR10	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K5	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K6	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
R1	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R2	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R3	Resistor, fixed, composition, 1.5 kilohm, ±5%, 1/4 W	1-945000-166	01121	CB1525
R4	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R5	Resistor, fixed, composition, 33 kilohm, ±5%, 1/4 W	1-945000-198	01121	CB3335
R6	Resistor, fixed, composition, 3.3 megohm, ±5%, 1/4 W	1-945000-246	01121	CB3355
R7	Resistor, fixed, composition, 33 kilohm, ±5%, 1/4 W	1-945000-198	01121	CB3335
R8	Resistor, fixed, composition, 100 kilohm, ±5%, 1/4 W	1-945000-210	01121	CB1045

Table 7-5. Parts List for Digital-to-Analog Converter Assembly, A2 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R9	Resistor, fixed, composition, 20 kilohm, ±5%, 1/4 W	1-945000-193	01121	CB2035
R10	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R11	Resistor, fixed, composition, 33 kilohm, ±5%, 1/4 W	1-945000-198	01121	CB3335
R12	Resistor, fixed, composition, 3.3 megohm, ±5%, 1/4 W	1-945000-246	01121	CB3355
R13	Resistor, fixed, composition, 33 kilohm, ±5%, 1/4 W	1-945000-198	01121	CB3335
R14	Resistor, fixed, composition, 3.3 kilohm, ±5%, 1/4 W	1-945000-174	01121	CB3325
R15	Resistor, fixed, composition, 100 kilohm, ±5%, 1/4 W	1-945000-210	01121	CB1045
R16	Resistor, fixed, composition, 20 kilohm, ±5%, 1/4 W	1-945000-193	01121	CB2035
U1	Integrated circuit, operational amplifier	1-926064-001	27014	LM208H
U2	Integrated circuit, operational amplifier	1-926064-001	27014	LM208H
U3	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U4	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U5	Integrated circuit, dpst analog switch	1-926065-001	27014	AH2114CG
U6	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U7	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U8	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U9	Integrated circuit, dpst analog switch	1-926065-001	27014	AH2114CG
U10	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
Z1	Resistor, network	1-403570-001	88869	
Z2	Resistor, network	1-403569-001	88869	

Table 7-6. Parts List for Relay Driver Assembly, A3 & A4

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR5	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR6	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR7	Diode, silicon, Vr = 75 V, If - 10 mA	1-913007-002	03508	1N4148
CR8	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR9	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR10	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR11	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR12	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR13	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR14	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR15	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR16	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K5	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K6	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K7	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K8	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K9	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K10	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K11	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K12	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K13	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K14	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K15	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH

Table 7-6. Parts List for Relay Driver Assembly, A3 & A4 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
K16	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R2	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R4	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R5	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R6	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R7	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R8	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
U1	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U2	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U3	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U4	Integrated circuit, quad gate	1-926007-030	01295	SN7408N

Table 7-7. Parts List for Band Decoder and Digital Multiplexer Assemblies, A5, A6 and A7

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR5	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR6	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR7	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR8	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR9	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR10	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR11	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR12	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR13	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR14	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR15	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR16	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K5	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K6	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K7	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K8	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
Q1	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q2	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q3	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q4	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q5	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q6	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q7	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q8	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
R1	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R2	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615

Table 7-7. Parts List for Band Decoder and Digital Multiplexer Assemblies, A5, A6 and A7 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R3	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R4	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R5	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R6	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R7	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R8	Resistor, fixed, composition, 360 ohm, ±5%, 1/4 W	1-945000-151	01121	CB3615
R9	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R10	Resitor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R11	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R12	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R13	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R14	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R15	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R16	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
U1	Integrated circuit, hex-inverter	1-926007-028	01295	SN7405N
U2	Integrated circuit, hex-inverter	1-926007-028	01295	SN7405N
U3	Integrated circuit, dual decoder	1-926007-034	01295	SN74155N
U4	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U5	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U6	Integrated circuit, 4 bit, bistable latches	1-926007-021	01295	SN7475N
U7	Integrated circuit, data selector	1-926007-033	01295	SN74151N
U8	Integrated circuit, quad gate	1-926007-001	01295	SN7400N

Table 7-8. Parts List for Analog Multiplexer Assembly, A8

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, ceramic, 0.01 uF, ±10%, 100 V dc	1-900104-005	00656	3419-100C-103K
C2	Capacitor, fixed, ceramic, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
C3	Capacitor, fixed, ceramic, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
R1	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R2	Resistor, fixed, composition, 5.1 kilohm, ±5%, 1/4 W	1-945000-179	01121	CB5125
R3	Resistor, variable, cermet, 500 ohm, ±10%, 1/2 W	1-945104-002	80294	3282W-1-501
R4	Resistor, fixed, film, 9.76 kilohm, ±1%, 1/10 W	1-945027-288	07115	RN55D9R76F
R5	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R6	Resistor, fixed, film, 8.06 kilohm, ±1%, 1/10 W	1-945027-280	07115	RN55D8R06F
R7	Resistor, variable, cermet, 2 kilohm, ±10%, 1/2 W	1-945104-004	80294	3282W-1-202
R8	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R9	Resistor, fixed, film, 2.55 kilohm, ±1%, 1/10 W	1-945027-232	07115	RN55D2R55F
R10	Resistor, fixed, film, 10 kilohm, ±1%, 1/10 W	1-945027-289	07115	RN55D1002F
R11	Resistor, fixed, composition, 1 megohm, ±5%, 1/4 W	1-945000-234	01121	CB1055
R12	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R13	Resistor, fixed, composition, 2.2 kilohm, ±10%, 1/4 W	1-945000-170	01121	CB2225
R14	Resistor, variable, cermet, 200 ohm, ±10%, 1/2 W	1-945104-001	80294	3282W-1-201
R15	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103

Table 7-8. Parts List for Analog Multiplexer Assembly, A8 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R16	Resistor, fixed, film, 100 ohm, ±1%, 1/10 W	1-945027-097	07115	RN55D1000F
R17	Resistor, fixed, film, 100 ohm, ±1%, 1/10 W	1-945027-097	07115	RN55D1000F
R18	Resistor, fixed, film, 2.61 kilohm, ±1%, 1/10 W	1-945027-233	07115	RN55D2611F
R19	Resistor, fixed, film, 16.2 kilohm, ±1%, 1/10 W	1-945027-309	07115	RN55D1621F
R20	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R21	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R22	Resistor, fixed, composition, 5.6 kilohm, ±5%, 1/4 W	1-945000-180	01121	CB5625
R23	Resistor, fixed, composition, 2.7 megohm, ±5%, 1/4 W	1-945000-078	01121	CB2755
R24	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
U1	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U2	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U3	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U4	Integrated circuit, voltage comparator	1-926064-002	27014	LM211H
U5	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U6	Integrated circuit, 4-channel driver	1-926066-001	17856	DG172BK
U7	Integrated circuit, multivibrator	1-926068-001	04713	MC9601L
U8	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U9	Integrated circuit, 4-channel driver	1-926066-001	17856	DG172BK
U10	Integrated circuit, 4-channel driver	1-926066-001	17856	DG172BK
U11	Integrated circuit, 4-channel driver	1-926066-001	17856	DG172BK
U12	Integrated circuit, 4-channel driver	1-926066-001	17856	DG172BK

Table 7-9. Parts List for Receiver Decode and Relay Driver Assembly, A9

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR5	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR6	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR7	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR8	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K5	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K6	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K7	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-945014-005	0000G	1A5AH
K8	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R2	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R4	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
U1	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U2	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U3	Integrated circuit, hex-buffer/driver	1-926007-036	01295	SN7406N
U4	Integrated circuit, triple gate	1-926007-009	01295	SN7410N
U5	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U6	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U7	Integrated circuit, 4-bit latch	1-926007-021	01295	SN7475N
U8	Integrated circuit, hex-buffer/driver	1-926007-036	01295	SN7406N

Table 7-10. Parts List for Logic Control Assembly, A10

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, ceramic, 100 pF, ±10%, 200 V dc	1-900072-020	04062	SCDM10-101J
C2	Capacitor, fixed, ceramic, 1.0 uF, ±10%, 50 V dc	1-900126-001	00656	CKR06BX105KL
C3	Capacitor, fixed, mica, 150 pF, ±5%, 200 V dc	1-900072-022	72136	SCDM10-151J
C4	Capacitor, fixed, mica, 150 pF, ±5%, 200 V dc	1-900072-022	72136	SCDM10-151J
C5	Capacitor, fixed, electrolytic, 10 uF, ±20%, 6 V dc	1-900057-021	56289	150D106X9006B2
C6	Capacitor, fixed, ceramic, 0.1 uF, ±20%, 50 V dc	1-900104-002	00656	3419-050E-104M
C7	Capacitor, fixed, ceramic, 1.0 uF, ±10%, 50 V dc	1-900126-001	00656	CKR106BX105KL
C8	Capacitor, fixed, ceramic, 330 pF, ±10%, 200 V dc	1-900072-029	04062	SCDM10-331J
Q1	Transistor, silicon, NPN	1-958086-002	04713	2N3211
R1	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R2	Resistor, fixed, composition, 4.7 kilohm, ±5%, 1/4 W	1-945000-178	01121	CB4725
R3	REsistor, variable, cermet, 50 kilohm, ±10%, 1/2 W	1-945104-009	80294	3282W-1-503
R4	Resistor, fixed, composition, 10 kilohm,± 5%, 1/4 W	1-945000-186	01121	CB1035
R5	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R6	Resistor, fixed, composition, 47 kilohm, ±5%, 1/4 W	1-945000-202	01121	CB4735
R7	Resistor, fixed, composition, 560 kilohm, ±5%, 1/4 W	1-945000-228	01121	CB5645
R8	Resistor, fixed, composition, 30 kilohm, ±5%, 1/4 W	1-945000-197	01121	CV3035
R9	Resistor, fixed, composition, 33 kilohm, ±5%, 1/4 W	1-945000-198	01121	CB3335
R10	Resistor, fixed, composition, 30 kilohm, ±5%, 1/4 W	1-945000-197	01121	CB3035
R11	Not used			
R12	Not used			
R13	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R14	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R15	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R16	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025

Table 7-10. Parts List for Logic Control Assembly, A10 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R17	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R18	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
U1	Integrated circuit, multivibrator	1-926067-001	04713	MC9602L
U2	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U3	Integrated circuit, dual-flip-flop	1-926007-012	01295	SN74107N
U4	Integrated circuit, multivibrator	1-926067-001	04713	MC9602L
U5	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U6	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U7	Integrated circuit, decoder	1-926007-010	01295	SN7442N
U8	Integrated circuit, 4-bit binary	1-926007-035	01295	SN74193N
U9	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U10	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U11	Integrated circuit, multivibrator	1-926067-001	04713	MC9602L
U12	Integrated circuit, multivibrator	1-926067-001	04713	MC9602L
U13	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U14	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U15	Integrated circuit, dual-flip-flop	1-926007-012	01295	SN74107N
U16	Integrated circuit, 4-bit binary	1-926007-035	01295	SN74193N

Table 7-11. Parts List for Digital Interface Assembly, A11

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R2	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R4	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R5	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R6	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R7	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R8	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R9	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R10	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R11	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R12	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R13	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R14	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R15	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R16	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R17	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R18	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R19	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R20	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R21	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R22	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R23	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R24	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025

Table 7-11. Parts List for Digital Interface Assembly, A11 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
U1	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U2	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U3	Integrated circuit, quad gate	1-926007-001	01295	SN7400N

Table 7-12. Parts List for Digital Pen Control Assembly, A12

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R2	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R4	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R5	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R6	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R7	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R8	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R9	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R10	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
U1	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U2	Integrated circuit, dual flip-flop	1-926007-012	01295	SN74107N
U3	Integrated circuit, dual flip-flop	1-926007-012	01295	SN74107N
U4	Integrated circuit, dual flip-flop	1-926007-012	01295	SN74107N
U5	Integrated circuit, triple gate	1-926007-009	01295	SN7410N
U6	Integrated circuit, 4-bit binary	1-926007-035	01295	SN74193N
U7	Integrated circuit, quad gate	1-926007-032	01295	SN7432N
U8	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U9	Integrated circuit, quad gate	1-926007-030	01295	SN7408N
U10	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U11	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U12	Integrated circuit, hex-inverter	1-926007-036	01295	SN7406N
U13	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U14	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N

Table 7-12. Parts List for Digital Pen Control Assembly, A12 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
U15	Integrated circuit, triple gate	1-926007-009	01295	SN7410N
U16	Integrated circuit, triple gate	1-926007-009	01295	SN7410N
U17	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U18	Integrated circuit, 4-bit binary	1-926007-035	01295	SN74193N

Table 7-13. Parts List for Auxiliary Multiplexer and Attenuator Control Assembly, A13

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R2	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R4	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R5	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R6	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R7	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R8	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R9	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R10	Not used			
R11	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R12	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R13	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R14	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
U1	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U2	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U3	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U4	Integrated circuit, 4-channel driver	1-926066-001	17856	DG172BK

Table 7-13. Parts List for Auxiliary Multiplexer and Attenuator Control Assembly, A13 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
U5	Not used			
U6	Integrated circuit, dual flip-flop	1-926007-029	01295	SN7407N
U7	Integrated circuit, quad gate	1-926007-030	01295	SN7408N
U8	Not used			
U9	Integrated circuit, quad gate	1-926007-030	01295	SN7408N

Table 7-14. Parts List for Sweep Select Assembly, A14

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
CR1	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR2	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR3	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR4	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR5	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR6	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR7	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR8	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
CR9	Diode, silicon, Vr = 75 V, If = 10 mA	1-913007-002	03508	1N4148
K1	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K2	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K3	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K4	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K5	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K6	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K7	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
K8	Relay, 1 pole, 1 position Coil: 5 V dc, 400 ohm	1-942014-005	0000G	1A5AH
Q1	Transistor, silicon, PNP	1-958086-003	04713	2N2907
Q2	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q3	Not used			
Q4	Not used			
Q5	Transistor, silicon, NPN	1-958086-003	04713	2N2907
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R2	Resistor, fixed, composition, 560 ohm, ±5%, 1/4 W	1-945000-156	01121	CB5615
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R4	Resistor, fixed, composition, 4.7 kilohm, ±5%, 1/8 W	1-945086-079	01121	BB4725
R5	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R6	Resistor, fixed, composition, 1 kilohm, ±5%, 1/8 W	1-945086-063	01121	BB1025
R7	Resistor, fixed, composition, 10 kilohm, ±5%, 1/8 W	1-945086-087	01121	BB1035
U1	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N

Table 7-14. Parts List for Sweep Select Assembly, A14 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
U2	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U3	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U4	Integrated circuit, quad gate	1-926007-030	01295	SN7408N
U5	Integrated circuit, quad gate	1-926007-031	01295	SN7420N
U6	Integrated circuit, hex-inverter	1-926007-027	01295	SN7404N
U7	Integrated circuit, dual gate	1-926007-031	01295	SN7420N

Table 7-15. Parts List for Calibration Voltage Source, Digital Buffer and Starter Logic Assembly, A15

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, electrolytic, 22 uF, ±20%, 15 V dc	1-900057-181	56289	150D226X00006B 2
C2	Capacitor, fixed, electrolytic, 22 uF, ±20%, 15 V dc	1-900057-181	56289	150D226X00006B 2
C3	Capacitor, fixed, electrolytic, 22 uF, ±20%, 15 V dc	1-900057-181	56289	150D226X00006B 2
C4	Capacitor, fixed, electrolytic, 22 uF, ±20%, 15 V dc	1-900057-181	56289	150D226X00006B 2
C5	Capacitor, fixed, mica, 330 pF, ±10%, 200 V dc	1-900122-029	00656	CKR05BX331KM
C6	Capacitor, fixed, ceramic, 0.01 uF, ±10%, 100 V dc	1-900104-005	00656	3419-100C-103K
CR1	Diode, zener, 12 V, ±10%, 500 mW	1-913078-003	04713	1N5242A
CR2	Diode, zener, 12 V, ±10%, 500 mW	1-913078-003	04713	1N5242A
Q1	Transistor, silicon, NPN	1-958086-001	04713	2N2222A
Q2	Transistor, silicon, PNP	1-958086-003	04713	2N2907
R1	Resistor, fixed, composition, 51 ohm, ±5%, 1/2 W	1-945001-131	01121	EB5105
R2	Resistor, fixed, composition, 430 ohm, ±5%, 1/4 W	1-945000-153	01121	CB4315
R3	Resistor, variable, cermet, 1 kilohm, ±10%, 1/2 W	1-945104-003	80294	3282W-1-102
R4	Resistor, fixed, film, 1.96 kilohm, ±1%, 1/10 W	1-945027-221	07115	RN55D1961F
R5	Resistor, fixed, composition, 51 ohm, ±5%, 1/2 W	1-945001-131	01121	EB5105
R6	Resistor, fixed, composition, 430 ohm, ±5%, 1/4 W	1-945000-153	01121	CB4315
R7	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
R8	Resistor, variable, cermet, 20 kilohm, ±10%, 1/2 W	1-945104-007	80294	3282W-1-203
R9	Resistor, fixed, film, 187 kilohm, ±1%, 1/10 W	1-945027-411	07115	RN55D1873F
R10	Resistor, variable, cermet, 10 kilohm, ±10%, 1/2 W	1-945104-006	80294	3282W-1-103
R11	Resistor, fixed, film, 200 kilohm, ±1%, 1/10 W	1-945027-414	07115	RN55D2003F
R12	Resistor, fixed, film, 20 kilohm, ±1%, 1/10 W	1-945027-318	07115	RN55D2002F
R13	Resistor, fixed, film, 20 kilohm, ±1%, 1/10 W	1-945027-318	07115	RN55D2002F
R14	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R15	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025

Table 7-15. Parts List for Calibration Voltage Source, Digital Buffer and Starter Logic Assembly, A15 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R16	Resistor, fixed, composition, 10 kilohm, ±5%, 1/4 W	1-945000-186	01121	CB1035
U1	Integrated circuit, hex-buffer/driver	1-926007-036	01295	SN7406N
U2	Integrated circuit, triple gate	1-926007-009	01295	SN7410N
U3	Integrated circuit, multivibrator	1-926068-001	04713	MC9601L
U4	Integrated circuit, operational amplifier	1-926036-002	07263	uA741C
U5	Integrated circuit, quad gate	1-926007-001	01295	SN7400N
U6	Integrated circuit, multivibrator	1-926068-001	04713	MC9601L

Table 7-16. Parts List for Auxiliary Multiplexer and Attenuator Control Assembly, A16

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R1	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R2	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R3	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
R4	Resistor, fixed, composition, 1 kilohm, ±5%, 1/4 W	1-945000-162	01121	CB1025
U1	Not used			
U2	Not used			
U3	Not used			
U4	Not used			
U5	Not used			
U6	Integrated circuit, hex-buffer/driver	1-926007-029	01295	SN7407N
U7	Integrated circuit, quad gate	1-926007-030	01295	SN7408N

Table 7-17. Parts List for Power Supply Assembly (Spec Controlled Purchased Item), PS1 and PS2

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, electrolytic, 470 uF, 15 V dc		0000K	32-13006-002
C2	Capacitor, fixed, electrolytic, 470 uF, 15 V dc		0000K	32-12006-002
C3	Capacitor, fixed, electrolytic, 9000 uF, 15 V dc		0000K	32-13007-001
C4	Capacitor, fixed, electrolytic, 9000 uF, 15 V dc		0000K	32-13007-001
C5	Capacitor, fixed, electrolytic, 1 uF, 50 V dc		0000K	32-13006-001
C6	Capacitor, fixed, film, 0.001 uF, 100 V dc		0000K	32-13005-008
C7	Capacitor, fixed, electrolytic, 1 uF, 50 V dc		0000K	32-13006-001
C8	Capacitor, fixed, electrolytic, 470 uF, 15 V dc		0000K	32-13006-002
C9	Capacitor, fixed, electrolytic, 470 uF, 15 V dc		0000K	32-13006-002
CR1	Diode, S1-2		0000K	11-13009-001
CR2	Diode, S1-2		0000K	11-13009-001
CR3	Diode, 3S1S		0000K	11-13010-001
CR4	Diode, 3S1S		0000K	11-13010-001
CR5	Diode, 3S1S		0000K	11-13010-001
CR6	Diode, 3S1S		0000K	11-13010-001
CR7	Not used			
CR8	Diode, S1-2		0000K	11-13009-001
CR9	Diode, zener, 1N751A		0000K	12-13025-006
CR10	Diode, 3S1S		0000K	11-13010-001
F1	Fuse, 15 A		0000K	63-16045-013
Q1	Transistor, 2N2222A		0000K	10-13019-001
Q2	Transistor, 13159-2		0000K	10-13159-002
Q3	Transistor, 13002-3		0000K	10-13002-003
Q4	Transistor, 2N2907A		0000K	10-13020-001
R1	Resistor, fixed, 51 ohm, ±5%, 1/2 W		0000K	20-13004-042
R2	Resistor, fixed, 51 ohm, ±5%, 1/2 W		0000K	20-13004-042
R3	Resistor, fixed, 3.01 kilohm, RN60C		0000K	21-13050-239
R4	Resistor, fixed, 4.02 kilohm, RN60C		0000K	21-13050-251
R5	Resistor, fixed, 47 kilohm, ±5%, 1/2 W		0000K	20-13004-113
R6	Resistor, fixed, 1 kilohm, ±5%, 1/2 W		0000K	20-13004-073

Table 7-17. Parts List for Power Supply Assembly (Spec Controlled Purchased Item), PS1 and PS2 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R7	Not used			
R8	Resistor, fixed, 3.3 kilohm, ±5%, 1/2 W		0000K	20-13004-085
R9	Resistor, fixed, 1 kilohm, ±5%, 1/2 W		0000K	20-13004-073
R10	Resistor, fixed, 0.05 ohm, 5 W		0000K	22-13049-001
R11	Resistor, variable, 100 ohm		0000K	23-13016-004
R12	Not used			
R13	Resistor, fixed, 510 ohm, ±5%, 1/2 W		0000K	20-13004-066
R14	Resistor, variable, 1.5 kilohm		0000K	23-13032-006
R15	Resistor (jumper)		0000K	
R16	Resistor, fixed, 1.5 kilohm, RN60C		0000K	21-13050-210
R17	Resistor, fixed, 100 ohm, ±5%, 1/2 W		0000K	20-13004-049
R18	Resistor, fixed, 1 kilohm, ±5%, 1/2 W		0000K	20-13004-073
R19	Resistor, fixed, 1 kilohm, ±5%, 1/2 W		0000K	20-13004-073
R20	Resistor, fixed, 1 kilohm, RN60C		0000K	21-13050-193
R21	Resistor (jumper)		0000K	
R22	Resistor, variable, 500 ohm		0000K	23-13016-007
R23	Resistor, fixed, 10 ohm, ±5%, 1/2 W		0000K	20-13004-025
R24	Resistor, fixed, 10 ohm, ±5%, 1/2 W		0000K	20-13004-025
SCR1	Silicon controlled rectifier, 2N4441		0000K	13-13015-001
U1	Integrated circuit, 723CE		0000K	14-13034-001

Table 7-18. Parts List for Power Supply Assembly (Spec Controlled Purchased Item) PS3 and PS4

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
C1	Capacitor, fixed, electrolytic, 1000 uF, 50 V		0000K	32-13007-010
C2	Capacitor, fixed, electrolytic, 1 uF, 50 V		0000K	32-13006-001
C3	Capacitor, fixed, film, 0.001 uF, 100 V		0000K	31-13005-008
C4	Capacitor, fixed, electrolytic, 1 uF, 50 V		0000K	32-13006-001
C5	Capacitor, fixed, electrolytic, 220 uF, 35 V		0000K	32-13006-004
CR1	Diode, S1-2		0000K	11-13009-001
CR2	Diode, S1-2		0000K	11-13009-001
CR3	Diode, S1-2		0000K	11-13009-001
CR4	Diode, S1-2		0000K	11-13009-001
CR5	Not used			
CR6	Diode, S1-2		0000K	11-13009-001
CR7	Diode, zener, 1N753A		0000K	12-13025-008
CR8	Diode, S1-2		0000K	11-13009-001
F1	Fuse, 1.25 A		0000K	63-16045-002
Q1	Transistor, 2N2222A		0000K	10-13019-001
Q2	Transistor, 2N2219A		0000K	10-13018-001
Q3	Transistor, 13002-3		0000K	10-13002-003
R1	Resistor, fixed, 33 ohm, ±5%, 1/2 W		0000K	20-13004-037
R2	Resistor, fixed, 2.2 kilohm, ±5%, 1/2 W		0000K	20-13004-081
R3	Not used			
R4	Resistor, fixed, 47 kilohm, ±5%, 1/2 W		0000K	20-13004-113
R5	Resistor, fixed, 1 kilohm, ±5%, 1/2 W		0000K	20-13004-073
R6	Not used			
R7	Resistor, fixed, 3.3 kilohm, ±5%, 1/2 W		0000K	20-13004-085
R8	Resistor, fixed, 0.82 ohm, BWH		0000K	24-13014-012
R9	Resistor, variable, 100 ohm		0000K	23-13016-004
R10	Not used			
R11	Resistor, fixed, 1.5 kilohm, ±5%, 1/2 W		0000K	20-13004-077
R12	Resistor, variable, 1.5 kilohm		0000K	23-13032-006
R13	Resistor, fixed, 511 ohm, RN60C		0000K	21-13050-165

Table 7-18. Parts List for Power Supply Assembly (Spec Controlled Purchased Item) PS3 and PS4 (Cont.)

Ref. Desig.	Description	Singer Part No.	Mfr. Code No.	Mfr. Part No.
R14	Resistor, fixed, 1.43 kilohm, RN60C		0000K	21-13050-208
R15	Resistor, fixed, 0.47 ohm, BWH		0000K	24 13014-009
R16	Resistor, fixed, 270 ohm, ±5%, 1/2 W		0000K	20-13004-059
R17	Resistor, variable, 500 ohm		0000K	23-13016-007
R18	Resistor, fixed, 270 ohm, ±5%, 1/2 W		0000K	20-13004-059
R19	Resistor, fixed, 560 ohm, ±5%, 1/2 W		0000K	20-13004-067
SCR1	Silicon controlled rectifier, 107F		0000K	13-16047-001
U1	Integrated circuit, 723CE		0000K	14-13034-001

Table 7-19. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbook H4-2.

Code No.	Manufacturer	Address
*0000A	Siliconics	Sunnyvale, Calif.
*0000B	Mura Corp.	Jericko, N.Y.
*0000C	Modutec	Norwalk, Conn.
*0000D	Signetics	Sunnyvale, Calif.
*0000E	Power Components	Scottdale, Pa.
*0000F	Hytronics Corp.	Pinellas Park, Fla.
*0000G	Electronic Application	So. El Monte, Calif.
*0000H	Buckeye Stamping Co.	Columbus, Ohio
*0000J	Corcom	Chicago, Ill.
*0000K	Powertec	Chatsworth, Calif.
00656	Aerovox Corp.	New Bedford, Mass.
00853	Sangamo Electric Co.	Marion, Ill.
01121	Allen-Bradley Co.	Milwaukee, Wis.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instrument, Inc., Transistors Products Div.	Dallas, Texas
01351	Dynamic Gear Co., Inc.	Amityville, N. Y.
01681	RCL Mfg. Co.	Riverside, N. J.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	RCA Semiconductors and Materials Div.	Sommerville, N. J.
03508	GE Semiconductor Prod. Div.	Syracuse, N. Y.
03606	RCA Electronic Prod. Div.	Camden, N. J.
03614	Bussman Mfg.	Los Angeles, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
04062	Elmenco Products Co.	New York, N. Y.
04651	Sylvania Elec. Prod. Inc.	Mountain View, Calif.
04713	Motorola Inc.	Phoenix, Arizona
06650	Bell and Howell Co.	Chicago, Ill.
07109	Oaktron, Industries	Monroe, Wis.
07115	Corning Glass Works, Electronic Components Dept.	Bradford, Pa.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
08514	Centralab	Milwaukee, Wis.
08718	ITT Cannon Electric Co.	Phoenix, Ariz.
09353	C & K Components Inc.	Newton, Mass
11636	Kings Electronics Co.	So. Pasadena, Calif.
11783	NY-Glass Inc.	Paramount, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Ariz.
14655	Cornell-Dublier Elec. Corp.	Plainfield, N. J.
14752	Electro Cube	So. Pasadena, Calif.
15801	Fenwall Electronics	Farmingham, Mass.

Table 7-19. Code List of Manufacturers

Code No.	Manufacturer	Address
15849	USECO	
16407	Nytronics Inc.	Lexington, Ky.
17856	Siliconix Inc.	Santa Clara, Calif.
24152	SEI Mfg.	Northridge, Calif.
24446	GE Corp.	Schenectady, N. Y.
24972	Telefunken Sales Corp.	Long Island, N. Y.
27014	National Semiconductor	Santa Clara Calif.
28480	Hewlett Packard	Palo Alto, Calif.
44655	Ohmite Mfg. Co.	Skokie, Ill.
56289	Sprague Electric Co.	North Adams, Mass.
71279	Cambridge Thermionic Corp.	Cambridge, Mass.
71450	CTS Corp.	Elkhart, Ind.
70903	Belden Mfg. Co.	Chicago, Ill.
71785	Cinch Mfg. Div. of United Carr	Chicago, Ill.
72136	Electro Motive Mfg. Co.	Willimantic, Conn.
72982	Erie Resistor Corp.	Erie, Pa.
73445	Amperex Electronics Co.	Hicksville, N. Y.
75042	International Resistance Co.	Philadelphia, Pa.
75915	Littlefuse Inc.	Desplaines, Ill.
76433	General Instrument Co.	Newark, N. J.
76493	Miller, J. W.	Los Angeles, Calif.
77068	Bendix Corp.	No. Hollywood, Calif.
80294	Bourns Laboratories Inc.	Riverside, Calif.
80740	Helipot, Div. of Beckman Industries	Fullerton, Calif.
80795	ITT Semiconductors	New York, N. Y.
81095	Triad	Venice, Calif.
81564	Artted Co. Inc.	Springfield, Mass.
82389	Switchcraft	Chicago, Ill.
83003	Varo Inc.	Garaland, Texas
83330	H. H. Smith	Brooklyn, N. Y.
88869	Singer Instrumentation	Los Angeles, Calif.
90201	Mallory P. R. and Co. Inc.	Detroit, Mich.
91293	Johanson Mfg. Co.	Boonton, N. J.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91737	Gremar Mfg. Co.	Wakefield, Mass.
95121	Quality Components Inc.	St. Marys, Pa.
95264	Lerco Electronics Inc.	Burbank, Calif.
95712	Dage Electric Co. Inc.	Franklin, Ind.
98003	Nielsen Hardware Corp.	Hartford, Conn.
98291	Sealectro Corp.	New Rochelle, N. Y.

*These vendors have no numbers assigned in the latest supplement to the Federal Supply Code for Manufacturers H4-2

Section VIII

SCHEMATIC DIAGRAMS

HIGHEST REF DESIGNATIONS USED					
R48	CR4	C8	U14	K1	
REF DESIGNATIONS NOT USED					
R47, C3					

6. WAVEFORM SHOWN, WHEN IN SWEEP POSITION.
5. CR2, CR3 & CR4 ARE IN4148.
4. GROUND APPLIED TO PIN 7 OF U2, U5, AND U8.
3. +5 VDC APPLIED TO PIN 14 OF U2, U5 AND U8.
2. ALL RESISTORS ARE 1/8W, 5%
1. ALL VARIABLE RESISTORS ARE 22 TURN CERMET (BOURNS SERIES 3282W)

Figure 8-1. Schematic Diagram, Sweep Generator Assembly, A1 Dwg No. 4-501297-001 (D)

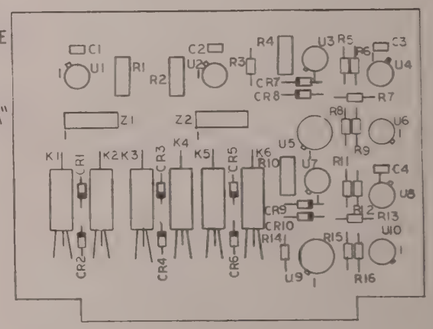
CAL.SW. 21
24 PLOT X-DATA T
4 PLOT X-DATA 7
−10V H
X 2^2 J
1 PLOT X-DATA 8
8 OR 16 PLOT X-DATA M
$X2^3$ 9
$X2^0$ N
$X2^1$ 15
16 OR 24 PLOT Y-DATA E
$Y2^0$ F
GND 22 Z
+5V 1 A
$Y2^1$ 4
+10V 6
4 OR 8 PLOT Y-DATA D
1 PLOT Y-DATA C
−15V 11
+15V 2 8
REC. SLEW RATE 19
CAL. SW. 20

K3 K4 K5 K6 K1 K2
CR4 CR3 CR6 CR5 CR2 CR1

Z2: R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 — DALE SPR820
Z1: R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 — DALE SPR819

U2 LM208H: R3 1.5K; C2 100pF ±10% 200VDC
U1 LM208H: C1 100pF ±10% 200VDC
R2 10K ±10% 1/2W; R1
U6: R9 20K; R6 3.3M
U10: R16 20K; R12 3.3M
CR7 CR8 CR10 CR9
U4: C3 0.1μF ±10% 50VDC
U8: C4 ±10% 0.1μF 50V
U3: R4 10K ±10% 1/2W
U7: R10 10K ±10% 1/2W
U5 AH2114CG: R8 100K; R5 33K
U9 AH2114CG: R15 100K; R14 3.3K; R11 33K
R7 33K; R13 33K
+15V, −15V, 12

R RECORDER "X" VOLTAGE
16 REC "X DATA"
5 REC "Y" VOLTAGE
17 REC "Y DATA"



HIGHEST REF DESIGNATIONS USED						
C4	CR10	K6	R16	U10	Z2	
REF DESIGNATIONS NOT USED						

5. ALL VARIABLE RESISTORS ARE 22 TURN (BOURNS SERIES 3282W)
4. ALL OPERATIONAL AMPLIFIERS ARE UA741C.
3. ALL RELAYS ARE 1-942014-005.
2. ALL DIODES ARE IN4148.
1. ALL RESISTORS ARE IN OHMS ±5%, 1/4W.

Figure 8-2. Schematic Diagram, D/A Converter Assembly, A2 Dwg No. 4-501298-001 (A)

RCVR+12V.

A4 = CAL
A3 = BW1
RMt

A4 = F I
A3 = BW2
RMt

+5V

A4 = QP
A3 = BW3
RMt

GND

A4 = DP1
A3 = BW4
RMt

RCVR+12V.

RCVR+12V.

RCVR+12V.

HIGHEST REF DESIGNATION USED			
R8	CR16	K16	U4

5. PIN 7 OF U1 THPU U4 IS CONNECTED TO GND.
4. PIN 14 OF U1 THRUU4 IS CONNECTED TO +5V.
3. DIODES CR1 THRU CR16 ARE IN4148.
2. RELAYS K1 THRU K16 ARE 1-942014-005.
1. RESISTORS R1 THRU R8 ARE 1K, 1/4W, ±5%

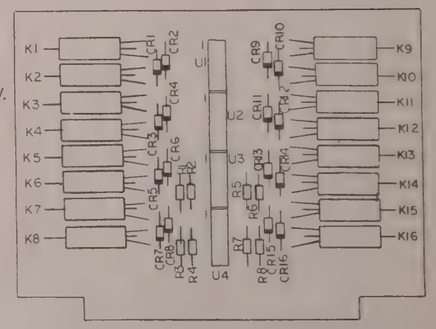
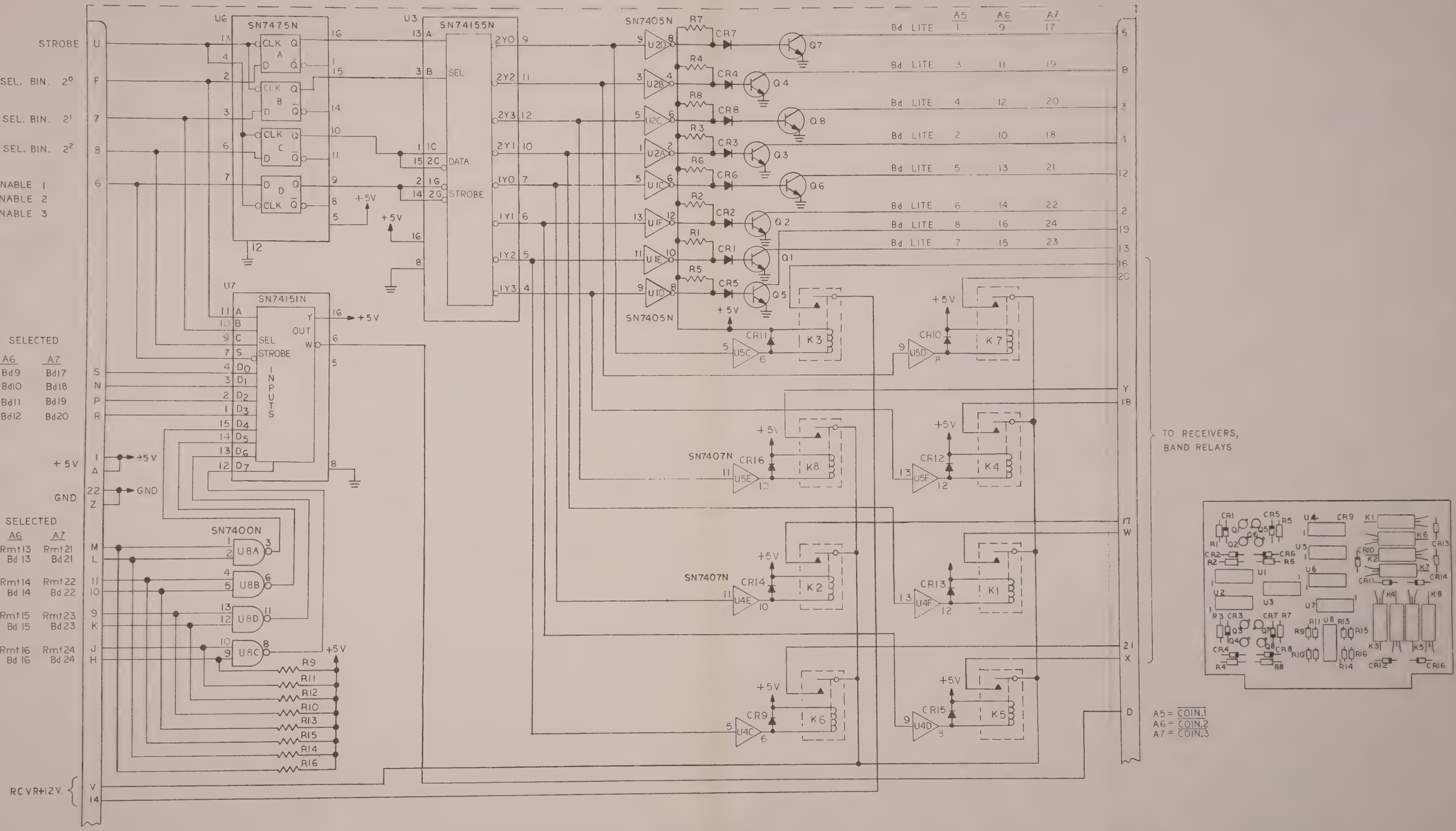


Figure 8-3. Schematic Diagram, Relay Driver Assembly, A3, A4 Dwg No. 4-501299-001 (A)



HIGHEST REF DESIGNATIONS USED				
R16	CR16	Q8	U8	K8

7. ALL RELAYS ARE 1-942014-005
6. PIN 14 OF U1,2,4,5,8 IS CONNECTED TO +5 V
5. PIN 7 OF U1,2,4,5,8 IS CONNECTED TO GROUND.
4. TRANSISTORS Q1 THRU Q8 ARE 2N2222A.
3. RESISTORS R1 THRU R8 ARE 360Ω ±5%, 1/4 W.
2. RESISTORS R9 THRU R16 ARE 1K, ±5%, 1/8 W
1. DIODES CR1 THRU CR16 ARE IN4148

Figure 8-4. Schematic Diagram, Band Decoder and Multiplexer Assembly, A5 thru A7 Dwg No. 4-501300-001 (A)

CAL.SW. X OPER. W MAX. Y ZERO

NM-7 LOG VIDEO 18
NM-17/27 LOG VIDEO 17
NM-37/57 LOG VIDEO V
NM-67 LOG VIDEO U

+10V 3

SWEEP VOLTAGE 21
MAN. POT AMP. 20
TUNE VOLTAGE S
GND. 22

COIN 1-2-3 8

NM-7 dB READOUT 10
NM-17/27 dB READOUT 9
NM-37/57 dB READOUT N
NM-67 READOUT M
−15V 11

SEL.-17 H
SEL.-37 F
SEL.-67 6

NM-7 Y VOLTAGE L
NM-17/27 Y VOLTAGE K
NM-37/57 Y VOLTAGE S
NM-67 Y VOLTAGE T

SEL.-7 7

+10V J
+5V 1
A
+15V 2

NM-7 SIMUL. FI 12
NM-17/27 SIMUL. FI 13
NM-37/57 SIMUL FI 15
NM-67 SIMUL FI 16

GND 22
Z

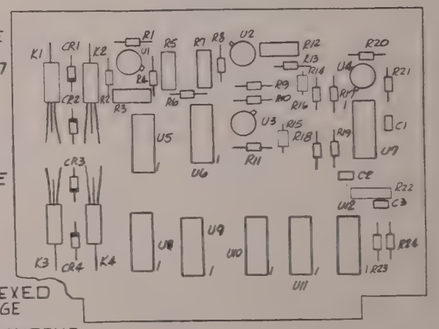
U11 DG172BK
U12 DG172BK
U9 DG172BK
U6 DG172BK
U10 DG172BK
U8B U8C U8A U8E U8F U8D
SN7404N
U4 LM211H
U7 MC9601L MAN. MARKER MV
U1 U2 U3 µA741C
U5B U5D U5E U5C U5F SN7407N

R18 2.61K 1/10W 1%
R19 16.2K 1/10W 1%
R16 100 1/10W 1%
R17 100 1/10W 1%
R20 1K
R21 10K
C2 0.1µF
C1 .01µF
C3 0.1µF
R22 5.6K
R23 2.7M
R24 10K
R1 10K, 1/10W, 1%
R4 9.76K 1/10W, 1%
R3 500
R2 5.1K
R5 10K
R11 1M
R15 10K
R14 200
R9 2.55K 1/10W, 1%
R8 10K, 1/10W, 1%
R13 2.2K
R12 10K
R6 8.06K 1/10W, 1%
R7 2K (REC. "Y" POS)
R10 10K 1/10W, 1%

CR2 CR3 CR1 CR4
K2 K3 K1 K4

CRT Y DATA 19

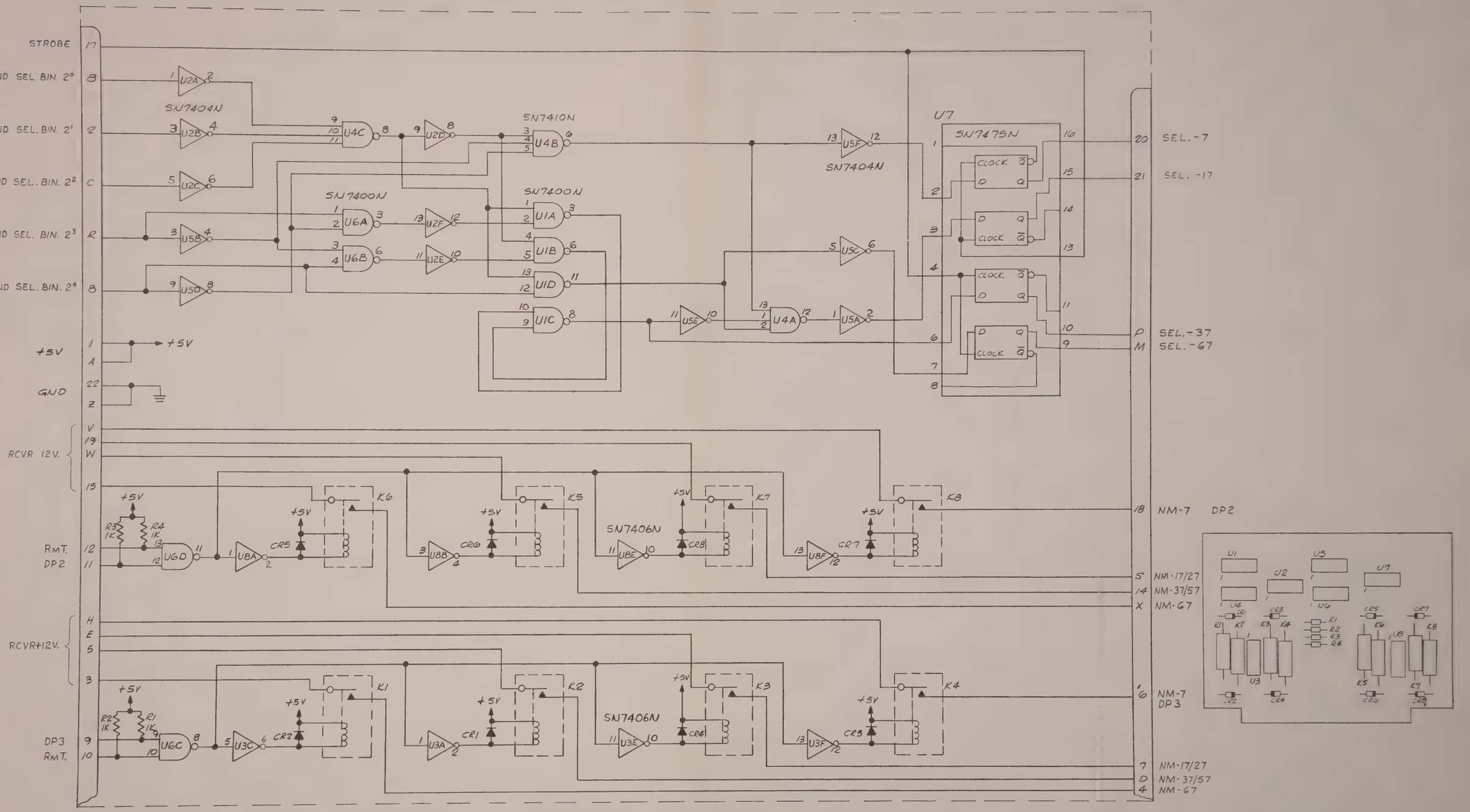
P DIGITAL DISPLAY (dB READOUT)
D TUNE VOLTAGE TO NM-67
B TUNE VOLTAGE TO NM 37/57
C TUNE VOLTAGE TO NM17/27
E TUNE VOLTAGE TO NM 7
R MULTIPLEXED Y-VOLTAGE
14 SIMULTANEOUS FI
4



HIGHEST REF DESIGNATION USED				
U12	R24	C3	K4	CR4
REF DESIGNATION NOT USED				

8. WAVEFORM SHOWN, WHEN IN SWEEP POSITION
7.
6. ALL VARIABLE RESISTORS ARE 10 TURN (BOURNS SERIES 3282W)
5. ALL RELAYS ARE 1-942014-005
4. GND APPLIED TO PIN 7 ON U5, U7 AND U8.
3. +5VDC APPLIED TO PIN 14 ON U5 U7 AND U8.
2. ALL DIODES ACE IN4148.
1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%

Figure 8-5. Schematic Diagram, Analog Multiplexer Assembly, A8 Dwg No. 4-501301-001 (B)



HIGHEST REF DESIGNATION USED			
CR8	R4	K8	U8

5. GND APPLIED TO PIN 7 OF U1 THRU U6, U8 AND PIN 12 OF U17
4. +5VDC APPLIED TO PIN 14 OF U1 THRU U6, U8 AND PIN 5 OF U7.
3. ALL RELAYS ARE 1-942014-005
2. ALL DIODES ARE IN4148.
1. ALL RESISTOR VALUES ARE IN OHMS, 1/2 W, 1%.

Figure 8-6. Schematic Diagram, Receiver Decode and Relay Driver Assembly, A9 Dwg No. 4-501302-001 (B)

REMOTE START C
START PULSE 2
+5V 1
A
SED E
MANUAL J
MANUAL H
GND 22
Z
CRT 10
REMOTE RESET 4
RESET 3
RESET D
INT. AUTO. RESET 11
INT. AUTO. RESET 5
Rc 6
T3 16
COIN 1 13
COIN 2 15
COIN 3 14

F STROBE
N T1
K T2
M T3
U T5
P T7
R T9
TIMING PULSES
9 RL
7 RS
T STROBE
8 RS
18 2°
17 2¹
19 2²
X 2⁴
20 ENABLE 1
21 ENABLE 2
Y ENABLE 3
V START "SWEEP & PEN"
12 2³ BAND SEL BIN

R13 1K
R3 50K
R2 4.7K
R1 10K
C2 1uF
C1 100pF
U3B START LATCH SN74107N
MC9602L START MV U1B
SN74107N U3B CLOCK INH1B
MC9602L U1A CLOCK STARTER Pw≈0.3uS
U8A U8D SN7400N
U6A SN7400N
U9A SN7404N
R18 1K
R17 1K
U6D U6C U6B SN7400N
R4 10K
R5 10K
C3 150pF
C4 150pF
MC9602L U4A (1/2) CLOCK Pw≈1uS
MC9602L U4B (1/2) CLOCK Pw≈1uS
SN74193N 4BIT COUNTER U8
SN7442N BCD DECODER U7
U9B U9C U9D U9F U9E SN7404N
U10A U10D U13F
U10B SN7400N
R14 1K
R16 1K
R15 1K
R9 33K
C7 1uF
RESET O/S MC9602L U12A
U5A U5D U5B SN7400N
R10 27K
C8 330pF
MC9602L U12B COIN O/S
U5C U14D U14A U14C U13E SN7400N
R7 560K
R6 47K
Q1 2N3211
C5 10uF 6V
R8 30K
C6 0.1uF
Pw≈3 SEC MC9602L U11A RECORDER DWELL
Pw≈1mS MC9602L U11B SWEEP START
U15A SN74107N ENABLE HOLD OFF
SN74193N U16 4BIT COUNTER CARRY
U13A J 1BIT COUNTER CD SN74107N U15B
U17A U17C U17B SN7410N
U13D U14B SN7404N

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
2. +5V APPLIED TO PIN 14 OF U2,3,5,6,9,10,13,14,15,17 AND PIN 16 OF U1,4,7,8,11,12,16.
3. GND APPLIED TO PIN 7 OF U2,3,5,6,9,10,13,14,15,17 AND PIN 8 OF U1,4,7,8,11,12,16.

HIGEST REF DESIGNATION USED
R16 | C8 | U17 | Q1
REF DESIGNATION NOT USED
R11, R12

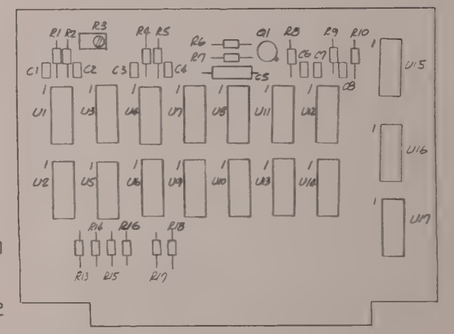
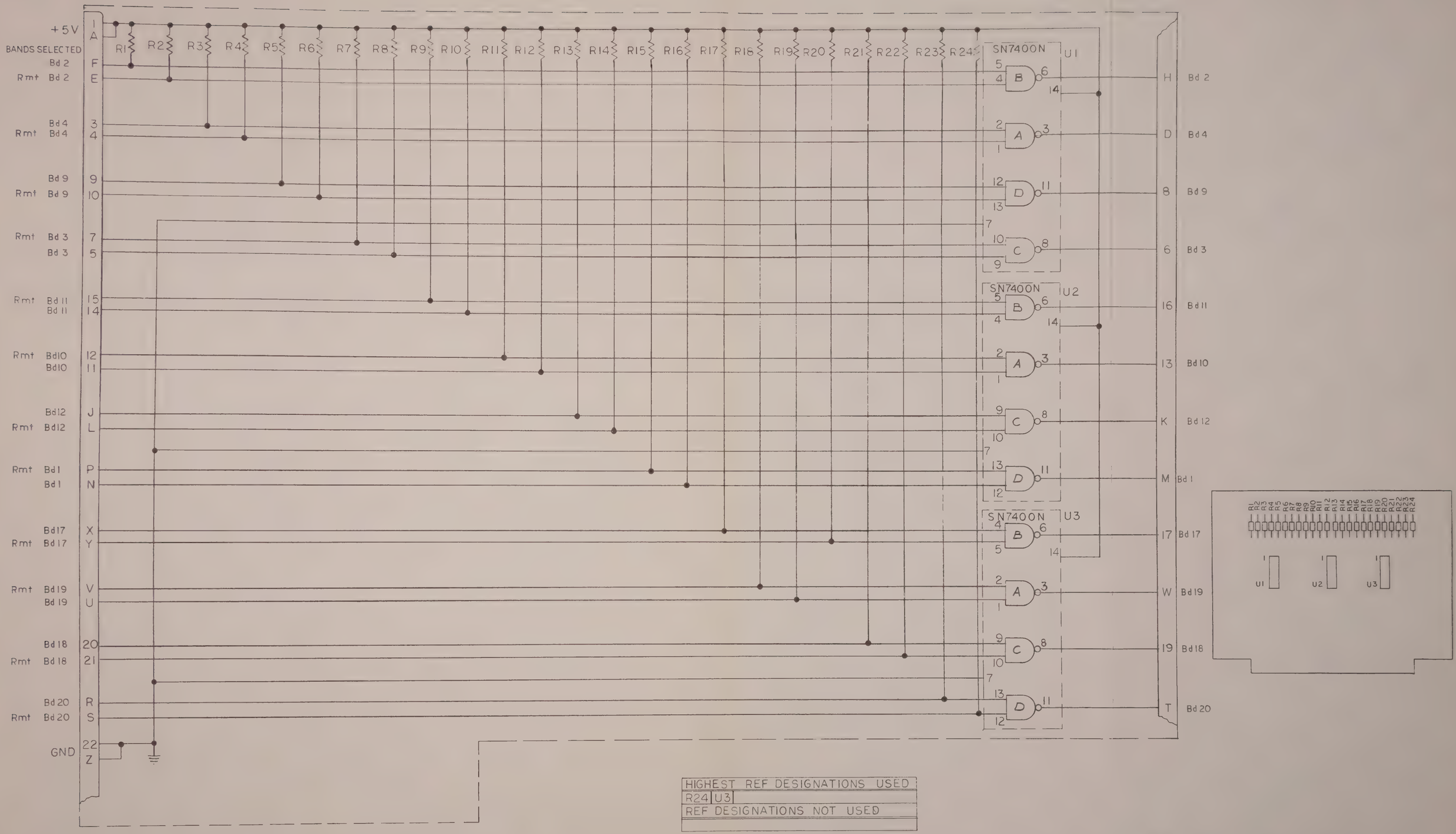


Figure 8-7. Schematic Diagram, Logic control Assembly, A10 Dwg No. 4-501303-001 (C)



HIGHEST REF DESIGNATIONS USED	
R24	U3
REF DESIGNATIONS NOT USED	

Figure 8-8. Schematic Diagram, Digital Interface Assembly, A11 Dwg No. 4-501304-001

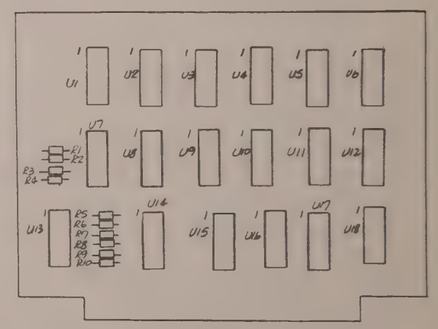
1 ALL RESISTORS ARE 1K, ±5%, 1/4W

T1 U
GND 22 GND
Z
T9 K
+5V J +5V
A
T7 10
T5 H

Rmt 24 PLOT 4
24 PLOT 5
Rmt 16 PLOT 2
16 PLOT 3
Rmt 8 PLOT B
8 PLOT C
Rmt 4 PLOT E
4 PLOT D
Rmt 1 PLOT 7
F
COIN 1·2·3 8
$\overline{R_L}$ J

SN7404N U14E, U14F, U14D, U1A, U14A
SN7410N U15B, U15C, U16B, U15A
SN7408N U9D, U9C
SN7432N U7C, U7D, U7A, U7B
SN7400N U8C, U10D, U13D, U13C, U13B, U13A, U8B, U10C, U8D, U9B, U8A, U9A, U10A, U11C, U11D, U5A, U10B
SN7406N U12B, U12C, U12A, U12D, U12E, U12F
SN7404N U17A, U17E, U17B, U1D, U1E
SN7410N U17D, U16C, U17C, U16A, U11B, U5B, U5C
SN74193N U18 4 BIT Y COUNTER (D, C, CLR, A, LOAD, COUNT DOWN, B; Q4, Q8)
SN74107 U4 LAST X POSITION FF (J, CLK, K, CLR; Q, $\overline{Q}$)
SN74193 U6 4 BIT X COUNTER (B, C, COUNT UP, LOAD, D, A, CLR; Q4, Q8, Qc, Qd)
SN74107N U3A BAND I LOCK OUT FF; U3B X LOAD FF; U2A LOAD COMM. O/S; U2B COIN MEMORY (J, CLK, K, CLR; Q, $\overline{Q}$)
+5 +5V
R8 R7 R9 R10 R1 R2 R4 R3 R6 R5

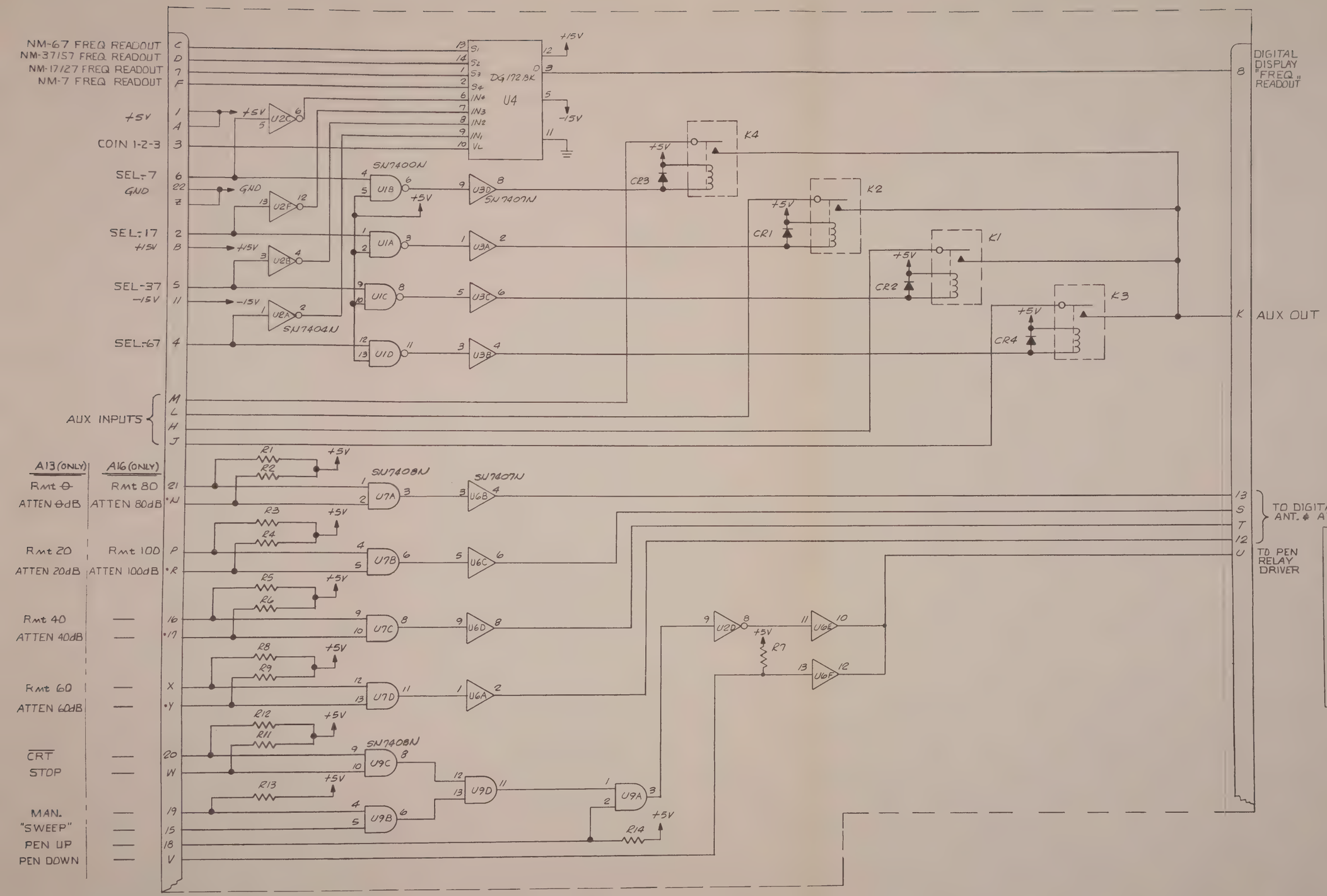
Y X2°
19 X2¹
20 X2²
21 X2³
RECORDER X POSITION
X Y2°
W Y2¹
RECORDER Y POSITION
U N.C.
V Rc



HIGHEST REFERENCE DESIGNATIONS USED	
R10	U18

3. GROUND APPLIED TO PIN 7 OF U1 THRU U13, U16, U17, U18 AND PIN 8 OF U14 AND U15.
2. +5VDC APPLIED TO PIN 14 OF U1 THRU U13, U15, U17, U18 AND PIN 16 OF U14 AND U15.
1. ALL RESISTORS ARE 1K OHMS, 1/8W, 5%.

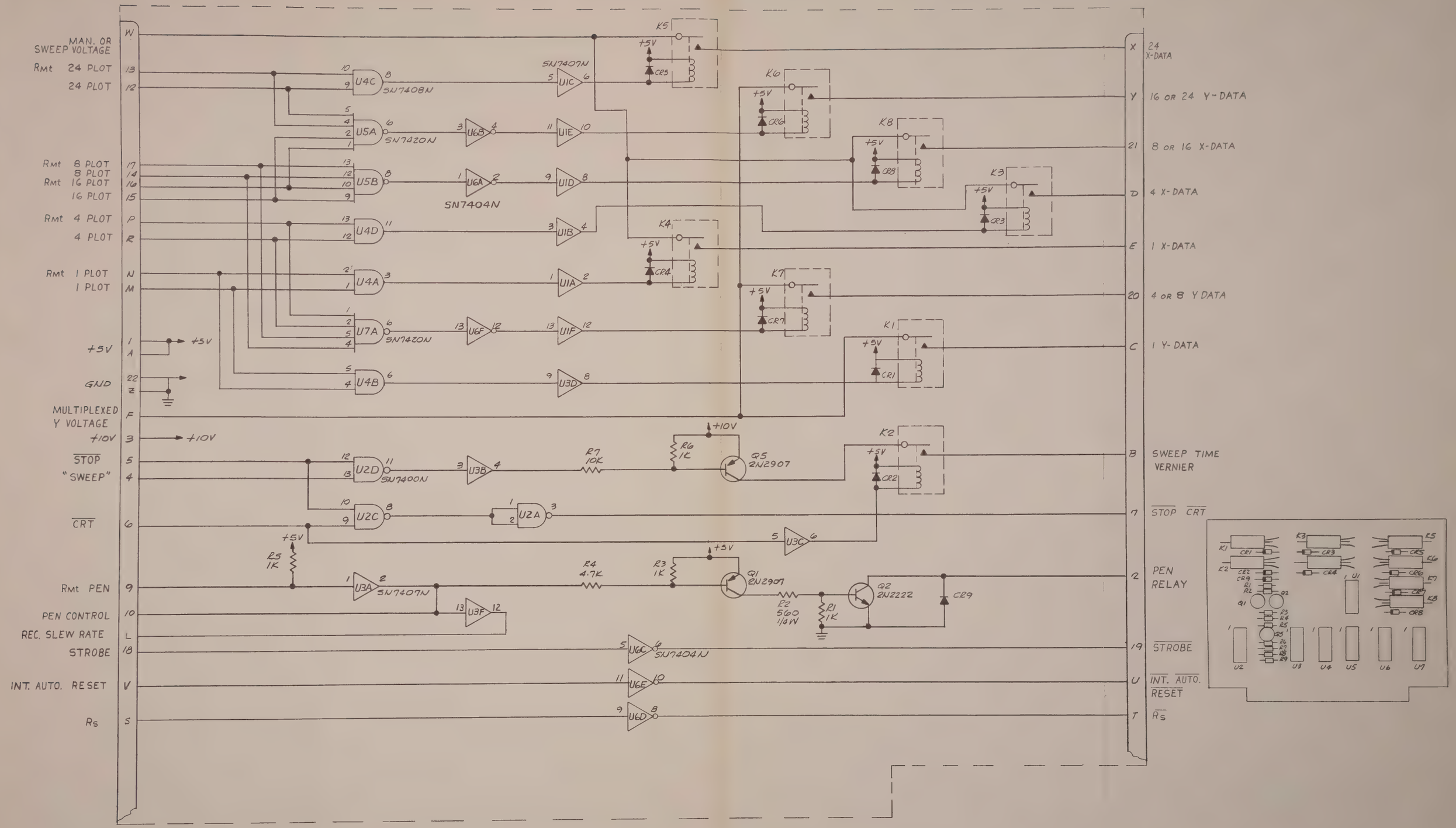
Figure 8-9. Schematic Diagram, Digital Pen Control Assembly, A12 Dwg No. 4-501305-001 (C)



6. A13 WITH ALL COMPONENTS INSTALLED.
   A16 WITH U6, U7 & R1-R4 INSTALLED ONLY.
5. GND APPLIED TO PIN 7 OF U1, U2, U3, U5, U6, U7 AND U8.
4. +5V DC APPLIED TO PIN 14 OF U1, U2, U3, U5, U6, U7 AND U8.
3. ALL RELAYS ARE 1-942014-005
2. ALL DIODES ARE IN4148.
1. ALL RESISTORS ARE 1K, 1/4W, 5%

HIGHEST REF DESIGNATION USED					
U9	R14		CR4	K4	
REF DESIGNATION NOT USED					
U5, U8	R10				

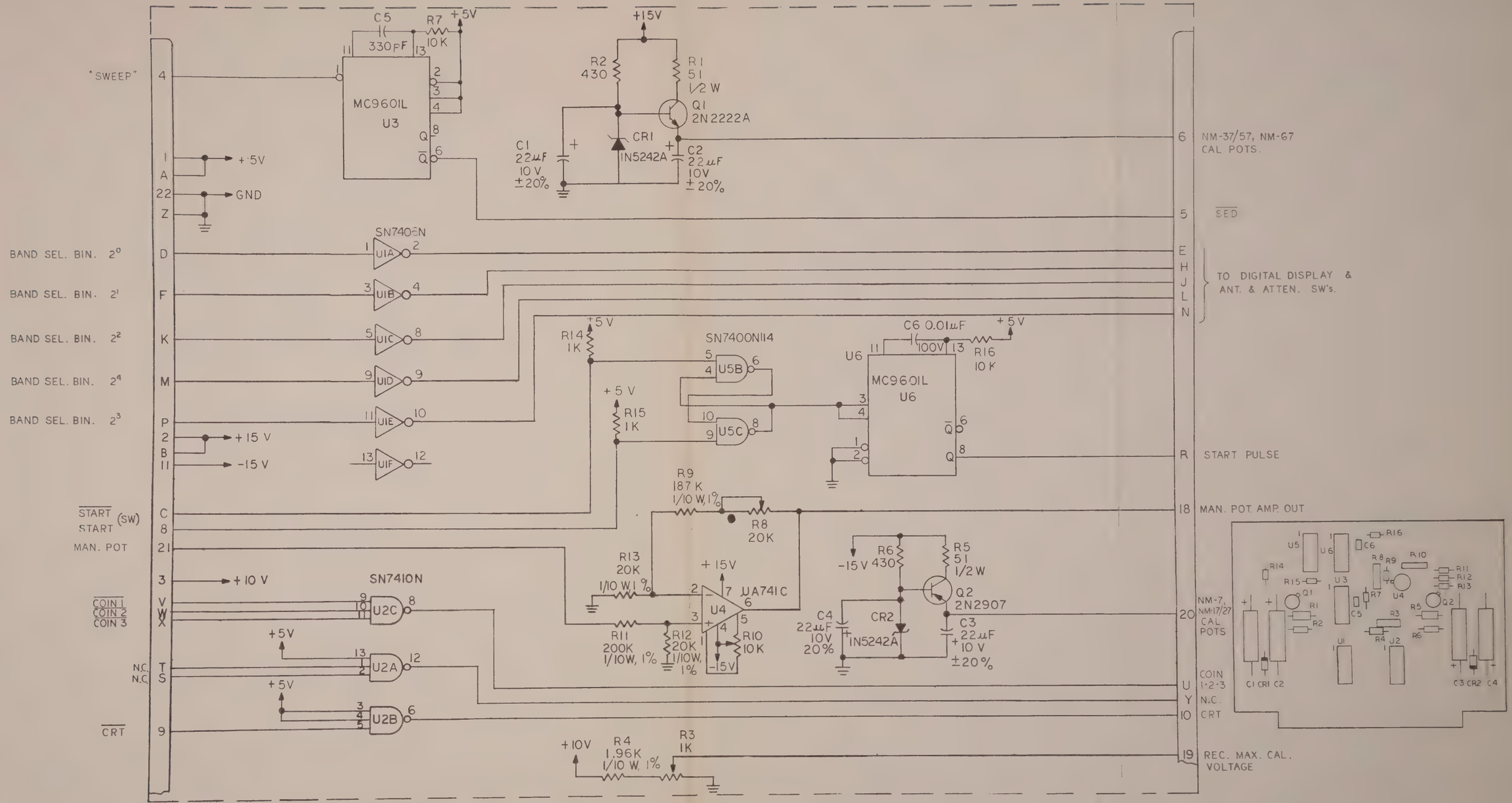
Figure 8-10. Schematic Diagram
Auxiliary Multiplexer and
Attenuator Control Assembly, A13 and A16
Dwg No. 4-501306-001 (B)



5. PIN 7 OF U1 THRU U7 IS CONNECTED TO GROUND
4. PIN 14 OF U1 THRU U7 IS CONNECTED TO +5V.
3. ALL RELAYS ARE 1-942014-005
2. ALL DIODES ARE IN4148
1. ALL RESISTORS ARE IN OHMS, 1/8W ±5%.

HIGHEST REF DESIGNATION USED					
CR9	R7	K8	Q5	U7	
REFERENCE DESIGNATIONS NOT USED					
Q3	Q4				

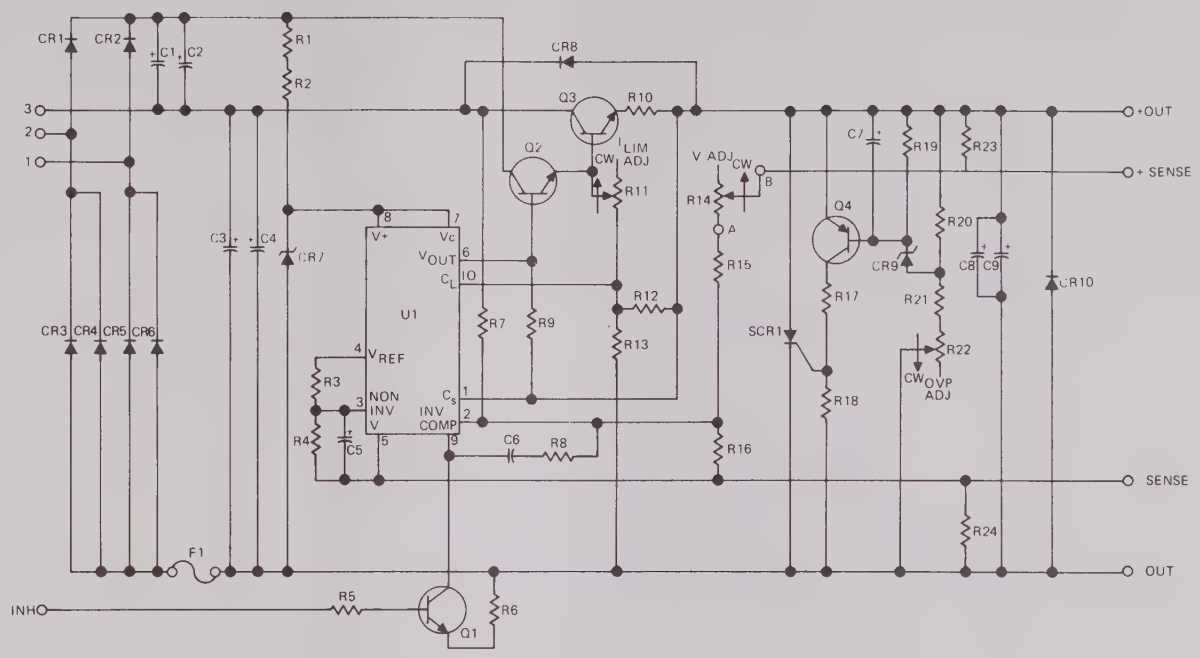
Figure 8-11. Schematic Diagram, Sweep Select Assembly, A14 Dwg No. 4-501307-001 (A)



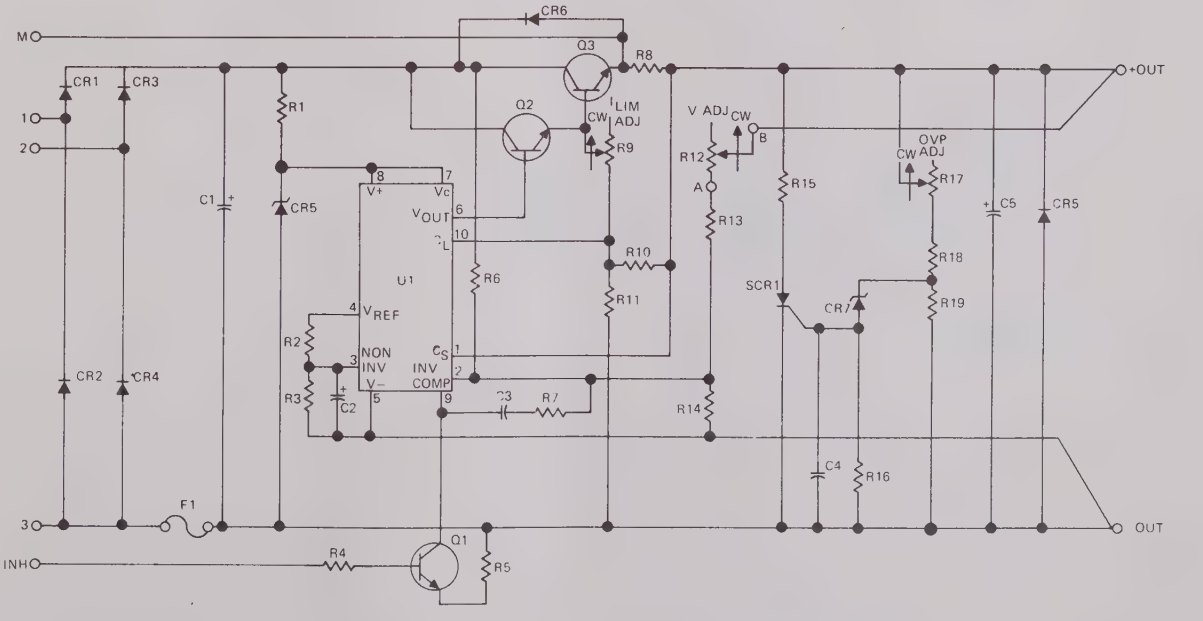
HIGHEST REF DESIGIGNATIONS USED
C6 CR2 R16 Q2 U6
REF DESIGNATIONS NOT USED

4. GND APPLIED TO PIN 7 ON U1, U2, U3, U5 & U6
3. +5VDC APPLIED TO PIN 14 ON U1, U2, U3, U5 & U6
2. ALL VARIABLE RESISTORS ARE 22 TURN (BOURNS SERIES 3282W.)
1. ALL RESISTOR VALUES ARE IN OHMS, ±5 %, 1/4 W

Figure 8-12. Schematic Diagram, Calibration Voltage Source, Digital Buffer and Starter Logic Assembly, A15 Dwg No. 4-501308-001 (B)

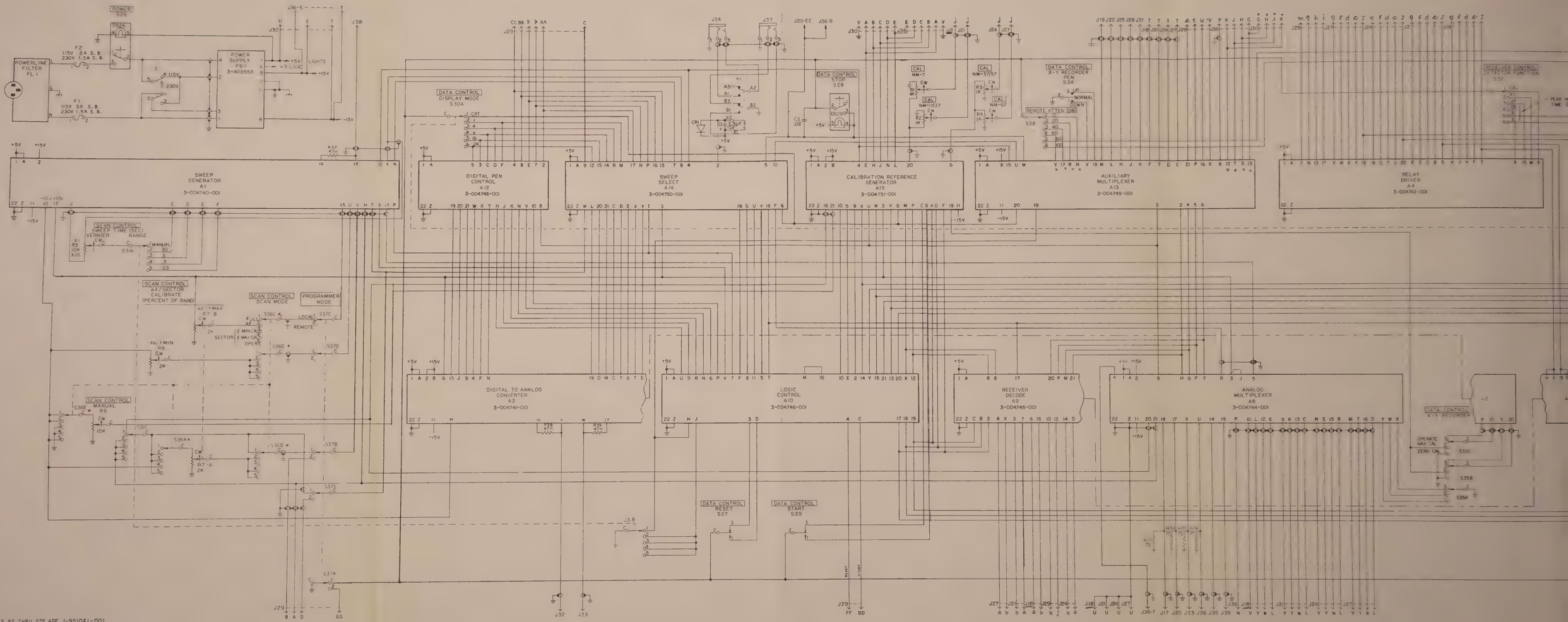


PS1 AND PS2



PS3 AND PS4

Figure 8-13. Schematic Diagrams, Power Supply Circuit Assemblies, (PS1, PS2, PS3, PS4)



2. S2 THRU S25 ARE 1-951041-001
1. R9 THRU R32 ARE 20 OHMS ±5 PCT 1/4 W

NOTES. UNLESS OTHERWISE SPECIFIED:

CONNECTORS					
REF.DES.	NOMENCLATURE		REF.DES.	NOMENCLATURE	
J17	LOG	NM-7	J29	REMOTE DIGITAL CONTROLLER	
J18	PROGRAM	NM-7	J30	ANTENNA SWITCH & ATTENUATOR	
J19	AUX	NM-7	J31	AUX OUTPUT	
J20	LOG	NM-17/27	J32	X DATA	X-Y RECORDER
J21	PROGRAM	NM-17/27	J33	Y DATA	X-Y RECORDER
J22	AUX	NM-17/27	J34	PEN CONTROL	X-Y RECORDER
J23	LOG	NM-37/57	J35	SIMULTANEOUS FI	
J24	PROGRAM	NM-37/57	J36	REMOTE DIGITAL DISPLAY	
J25	AUX	NM-37/57	J37	Z DATA	CRT
J26	LOG	NM-67	J38	X DATA	CRT
J27	PROGRAM	NM-67	J39	Y DATA	CRT
J28	AUX	NM-67			

AUXILIARY MULTIPLEXER A16 3-004749-005

RELAY DRIVER A3 3-004742-005

DIGITAL INTERFACE A11 3-004747-001

DIGITAL MULTIPLEXER A5 3-004743-001

DIGITAL MULTIPLEXER A6 3-004743-001

DIGITAL MULTIPLEXER A7 3-004743-001

NM-17/27 BAND (MHz)

NM-37/57 BAND (MHz)

NM-67

RECEIVER CONTROL BANDWIDTH S33

J18 = NM7

Figure 8-14. Wiring Diagram, Model P-7 Dwg No. 9-501324-001 (D)

APPENDIX A

BACKDATING INFORMATION FOR MODEL P-7 PROGRAMMER
Serial Numbers 101 thru 104

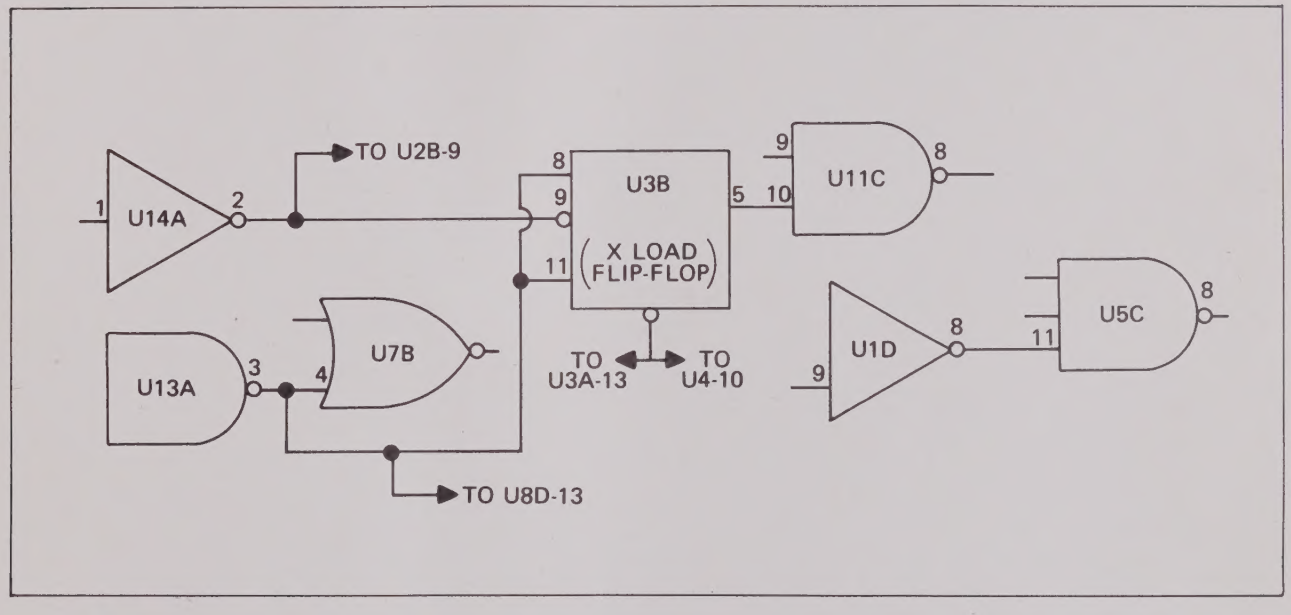
This manual refers directly to serial numbers 105 and above. The following information is provided to adapt this manual for serial numbers 101 thru 104.

Perform the following changes to the manual down to the effective serial number of your instrument.

Effective serial numbers: 101 thru 104

Page 5-20: Figure 5-8 and Page 8-19: Figure 8-9,

Add U3B as follows:



Page 5-11: Figure 5-5,

Delete J36-R and J29-EE and line to "stop line". Connect S31B common to S37A LOCAL position instead of directly to ground.

Effective serial number: 101 only

Page 7-12, Parts List:

Add C3, Capacitor, fixed, Mica, 100 pF, ± 5%, 500 Vdc, 1-900072-020, 04062, SCDM10-101J

Page 8-3, Schematic Diagram, A1:

Change U3 to LM208H

Add: C3 (100 pF 500 V ±5%) from U3-8 to ground.